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THE EDINBURGH PHILOSOPHICAL JOURNAL.

ART. I.—*Remarks on the Influence of Magnetism on the Rates of Chronometers.* By GEORGE HARVEY, M.G.S., M.A.S., &c. &c. * Communicated by the Author.

THE interest that has been latterly displayed respecting the influence of Magnetism on Chronometers, may plead an apology for the following contribution. Such, indeed, is the importance of the subject to the naval and commercial interests of the country, that every attempt to illustrate the effects of permanent and induced magnetism on those delicate machines, may be regarded as useful; since it is only from the accumulation of diversified experimental results, that we can hope fully to comprehend the real nature of the errors produced by this active and powerful agent.

The following experiments, part of an extensive course on the Influence of Permanent and Induced Magnetism on the rates of Chronometers, were undertaken principally with a view of ascertaining the effects which the former influence would have on their main springs, in consequence of its having been suspected, during the prosecution of some analogous inquiries, that the rate was subject to considerable fluctuations, according to the positions occupied by this part of the machine, with respect

* An account of a remarkable case of Magnetic Intensity of a Chronometer, by Mr Harvey, will be found in the *Transactions of the Royal Society of Edinburgh*, vol. x. part 1. now in the press.—ED.

to the direction of the magnetic force; and hence the situation of the spring, with relation to the attracting pole, was particularly attended to. The magnet was of the bar form, $13\frac{1}{2}$ inches long, $1\frac{1}{3}$ inches wide, a quarter of an inch thick, and possessing considerable power.

For this purpose, the magnet was placed in a horizontal position, in the direction of the magnetic meridian, with its north pole towards the northern horizon. A pocket-chronometer (A), possessing a very steady and uniform rate of $+ 20''.4$, (the mean of seventeen days' observation, and during which time the greatest deviation from the mean amounted only to three quarters of a second), was placed in the position denoted by Fig. 1. of Plate I., with the centre of its main-spring in the direction of the axis of the magnet, and the spring itself as nearly in contact with the north pole as the case of the chronometer would permit. The consequence of this application was, an immediate increase in the rate of the machine, from $+ 20''.4$ to $+ 65''.1$, and which it continued to maintain during the four days in which the chronometer occupied this position. By turning it, however, a quadrant, so as to bring the radial line passing through the centre of the spring into a position at right angles with the axis of the magnet, as in Fig. 2., the rate underwent a remarkable declension, from $+ 65''.1$ to $-23''.2$; being an alteration in its rate amounting to $88''.3$; and when the machine was afterwards brought into the position of Fig. 3., so that the centre of its main-spring might be again in a line with the prolonged axis of the magnet, the alteration was scarcely less remarkable; an increase having become immediately perceptible from $-23''.2$ to $+ 43''.4$; and when the chronometer was subsequently changed to the position of Fig. 4., with the radial line before alluded to at right angles to the magnetic axis, a losing rate was again perceptible, the change being from $+ 43''.4$ to $-2''.6$; and, on restoring the machine to the position it occupied in Fig. 1., the rate became $+ 72''.7$, a quantity greater by $7''.6$, than its former rate in the same situation;—affording another proof of the great accelerating influence of the magnet, when the attractive power was transmitted through the centre of the main-spring of the chronometer. The difference between the results obtained in the two applications of the chronometer, in the position denoted by Fig 1., will not

be regarded as considerable, when the remarkable changes the rate underwent in the different positions of the machine is fully considered. The chronometer was allowed to remain four days in each situation; and when finally detached from the magnet, its rate returned to + 18″.2; a quantity not very dissimilar to that which it possessed before its application to the magnet. The last-mentioned rate continued steady and uniform for several succeeding days. The preceding results are recorded in the following Table:

Situation of Chronometer (A).	Daily Rate.
Detached, - -	+ 20″.4
Fig. 1. Main-spring nearly in contact with the magnet, and the attractive power transmitted through its centre,	+ 65″.1
Fig. 2. Centre of the main-spring removed 90° from the preceding position, and the magnetic power transmitted nearly through the centre of the balance and its spring,	— 23″.2
Fig. 3. Centre of the main-spring 180° from its first situation, and the magnetic power transmitted through its centre, - - - -	+ 43″.4
Fig. 4. Centre of the main-spring 90° from its first situation, and the magnetic power transmitted nearly through the centre of the balance and its spring, -	— 2″.6
Fig. 1. Main-spring nearly in contact with the magnet, and the attractive power transmitted through its centre,	+ 72″.7
Detached, - -	+ 18″.2

The same experiments were afterwards repeated with a box-chronometer (B), (detached from its case), having a steady and uniform rate of — 2″.0. On being placed in the situation denoted by Fig. 1., the detached rate was changed to + 10″.0; but being turned, as in Fig. 2., the last-mentioned rate declined to + 3″.1; and when brought into the position of Fig. 3., the rate increased to + 5″.0; and when lastly moved, so as to correspond in situation with Fig. 4., the rate again declined to — 1″.1. Another series of observations, in similar positions of the chronometer, gave for Fig. 1. a rate of + 11″.7; for Fig. 2., a daily increment of + 3″.4; for Fig. 3., an average increase of + 7″.0; and for Fig. 4., a rate of + 1″ 4, each result being a

mean of four observations. In the following Table they are more conveniently arranged for inspection:

Situation of Chronometer (B).	Daily Rates of first set of Experiments.	Daily Rates of second set of Experiments.
Detached, - -	—2″.0	......
Fig. 1. Main-spring nearly in contact with the magnet, and the attractive power transmitted nearly through its centre, -	+10″.0	+11″.7
Fig. 2. Centre of the main-spring removed 90° from the preceding position, and the magnetic power transmitted nearly through the centre of the balance and its spring,	+3″.1	+3″.4
Fig. 3. Centre of the main-spring 180° from its first situation, and the magnetic power transmitted through its centre, -	+5″.0	+7″.0
Fig. 4. Centre of the main-spring 90° from its first situation, and the magnetic power transmitted nearly through the centre of the balance and its spring, -	—1″.1	+1″.4

From the preceding observations, it may be inferred, that the rate of a chronometer receives a considerable acceleration, when the centre of the main-spring is in the axis of the magnet produced; and that this acceleration attains a maximum, when the centre of the spring is at the least possible distance from the pole of the magnet, as denoted by Fig. 1.; and the next inferior degree of acceleration, when the same point is again found in the direction of the magnetic axis, after turning the chronometer through an arc of 180 degrees, as in Fig. 3. The maximum declension of rate was also observed to take place, when the radial line passing through the centre of the spring was at right angles to the magnetic axis, as in Fig. 2.; the balance being in this situation at its *least* distance from the pole, and the attractive power transmitted nearly through its centre. The minimum declension was likewise observed when the spring was placed as in Fig. 4., but the balance at its *greatest* distance from the same attractive pole, the magnetic power being directed nearly through its centre. *An increase of rate resulted, therefore, from the direct transmission of the magnetic influence through the centre of the main spring; and a diminution there*

of, when the same power passed through nearly the middle of the balance and its spring.

The effects produced on the rates of the preceding chronometers, by the direct transmission of the magnetic power through the centres of their respective main-springs, having been thus in some measure found, an attempt was next made to estimate what alterations of rate would result from the partial transmission of the attractive power through the same centre. For this purpose, chronometer (A) was again employed, and placed in the position represented in Fig. 5., so that a radial line proceeding from the centre of the time-keeper through the middle of the main-spring, might form an angle of 27° with the longitudinal axis of the magnet. The consequence of this application, was an immediate increase of + 20″.1, its detached rate, to + 52″.3; a quantity less than the mean of the two applications of the chronometer in the position denoted by Fig. 1., of + 16″.6. By turning the chronometer a quadrant, in order that the radial line before alluded to might form an angle of 117° with the axis of the magnet, as shewn in Fig. 6., and which position also brought the centre of the balance into the exact direction of the longitudinal axis of the magnet, the daily increment declined from + 52″.3 to + 29″.1; the magnitude of which rate, when contrasted with that observed in the same chronometer, when in the position of Fig. 2., being very remarkable. By again turning the machine through another quadrant, so as to bring the chronometer into the situation of Fig. 7., wherein the radial line formed with the axis an angle of 153°, and the attractive power of the magnet was only transmitted through small segments of the spring and balances, the rate was augmented from + 29″.1 to + 33″.7; being less than the rate determined for the same chronometer, when placed as in Fig. 3., by 9″.7. Lastly, by turning the time-keeper another quadrant, in order that the angle formed by the radial line and the axis should be 63°, as represented in Fig. 8., another declension in the rate took place, from + 33″.7 to + 18″.5; and when the machine was afterwards restored to the situation it occupied in Fig. 5., the rate again increased to + 52″.3, agreeing within 3″ of its former rate when in the same situation;—an aberration by no means considerable, when the great irregularities here alluded to are considered. These

+ 8″.5, agreeing within a second of its former rate in the same situation. The comparative influences of the two poles may be readily observed in the following Table:

Situation of Chronometer (B).	Applied to the North Pole of the Magnet.	Applied to the South Pole of the Magnet.
Fig. 10. Main-spring nearly in contact with the magnet, and the attractive power transmitted through its centre, - -	+ 11″.7	+ 9″.5
Fig. 11. Centre of the main-spring 90° from the preceding position, and the magnetic power transmitted nearly through the centre of the balance and its spring, the balance being at its least distance from the Pole,	+ 3″.4	— 4″.2
Fig. 12. Centre of the main-spring 180° from its first situation, and the magnetic power transmitted through its centre, - -	+ 7″.0	+ 8″.7
Fig. 9. Centre of the main-spring 90° from its first situation, and the magnetic transmitted nearly through the centre of the balance and its spring, the balance being at its greatest distance from the Pole, - -	+ 1″.4	— 0″.8

It may be proper, however, to remark, that at the time the chronometer (B) was successively applied to the south pole of the magnet, another chronometer (C) was placed at its north pole, as represented in Figures 9, 10, 11, and 12.; and that a series of experiments, similar to those already detailed, produced an effect on the last mentioned machine precisely the reverse of that which had been observed in chronometers (A) and (B). Thus, when the latter chronometer was applied to the south pole of the magnet, as in Fig. 9., the mean of two sets of observations gave a result of — 0″.9; but a mean of two sets of chronometer (C), when applied to the other pole, furnished an average rate of + 15″.7; the detached rate of the former machine having been — 2″.2, and of the latter + 2″.9; the positions of the balance and main-spring being precisely similar in both cases. In like manner, when the chronometers were posited, as in Fig. 10., the chronometer denoted by (B) gave a result of + 9″.5, at the same time that (C) furnished a mean rate of — 4″.2; and when the former produced an average rate of — 4″.2, in the situation represented in Fig. 11. (the perfect coincidence of the rates of two chronometers so differently cir-

cumstanced, is remarkable), the latter furnished $+22''.4$; and, lastly, when (B), in the position of Fig. 12., indicated a rate of $+8''.7$, the time-keeper (C) gave a result of $-8''.2$.

In a subsequent set of experiments, the chronometer (C) was successively applied to the south pole of the same magnet. The results are recorded in the following comparative Table, the time-keeper (B) being at the same time applied to the opposite pole.

Situation of Chronometer (C).	Daily Rate when applied to the North Pole.	Daily Rate when applied to the South Pole.
Plate 1. Fig. 9.	$+15''.7$	$+12''.0$
Fig. 10.	$-4''.2$	$+3''.2$
Fig. 11.	$+22''.4$	$+18''.6$
Fig. 12.	$-8''.2$	$-6''.6$

In each of the preceding examples, it will be observed that the accelerations in the rate took place when the magnetic power was transmitted through the centre of the balance; and the retardations, when it passed through the middle of the main spring. These results are the reverse of those recorded with respect to chronometers (B) and (C). In the pursuit of experimental science, every result ought to be fairly and impartially recorded. The admirable maxim of Bacon, *we cannot controul nature, unless by making her manifest,* should ever be present to the mind of the inquirer.

As an example of the comparative effects of the poles and equator of a circular magnetic plate, one of this form, 8 inches in diameter, and a quarter of an inch thick, was selected, and three chronometers (B), (D), (E) respectively applied to the parts here alluded to, as particularly represented in Fig. 13. The north pole of the plate is denoted by N, and when the time-keeper (B) was applied to it, so that its balance might be as near as possible to the pole, its detached rate of $-8''.1$ was changed into $+2''.2$; but, on afterwards applying the same part of the chronometer to the south pole, the gain, instead of being $10''.3$, as observed in its former situation, was only $1''.9$. In like manner, on placing the chronometer (E), with its ba-

lance as near as possible to the south pole of the plate, its detached rate of + 8″.5 was increased to + 27″.2; and, on detaching the chronometer from the magnet, the rate returned to + 8″.3, being only 0″.2 less than its former detached rate; and which, considering the powerful influence the time-keeper had been subject to, by the action of the magnet, was in some degree remarkable. By afterwards placing the same chronometer on the plate, so that the centre of its bottom should coincide with the middle of the magnet, and that a radial line proceeding from the centre of the chronometer through the axis of the balance might be at right angles with the axis of the magnet, the rate declined from + 8″.3 to — 2″.6; so that the south pole of the magnet produced an increment of + 19″.0 in the rate, and its equator a decrement of 10″.9. So also, when the centre of the chronometer (D) was placed over the middle of the magnetized plate, and the radial line before alluded to was perpendicular to the axis of the magnet, the detached rate of + 2″.0 was increased to + 3″.1. On removing the chronometer, this rate declined to 0″.9; but, on applying the machine to the north pole of the plate, the last mentioned rate was augmented to + 3″.1, being the same as that produced when the time-keeper was applied to the equator of the plate; but the actual increment in the latter case was 2″.2, whereas in the former it was only 1″.1; a necessary effect of the superior energy of the pole of the plate. The great effect of the middle of the plate on the rates of the chronometer, will not be regarded as remarkable, when it is considered that only a single point of the chronometer could be applied to the equator of the magnet; and that both the balance and the main spring, were in each case beyond the centre of the plate; and consequently under the influence of an attractive force, less powerful than that developed by the poles of the magnet, but much superior to the effect of the actual equator of the plate.

One thing worthy of observation in these experiments is, the immediate influence which the magnet exercised on the chronometers, and likewise the freedom with which they lost the magnetic power, when the attractive influence was less energetically developed, either from a change in the position of the instrument, or from its being detached from the magnet altogether.

PLATE I.

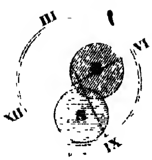
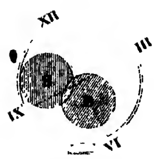
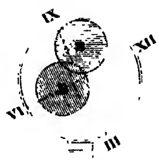
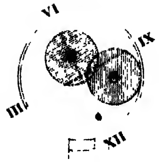





Fig. 1 Fig. 2 Fig. 3 Fig. 4

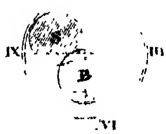
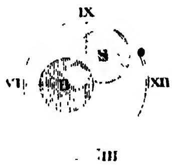
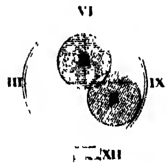





Fig. 5 Fig. 6 Fig. 7 Fig. 8

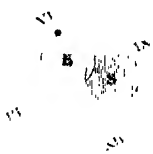
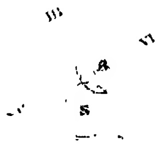
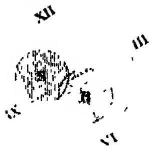
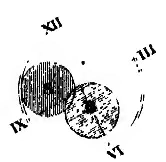
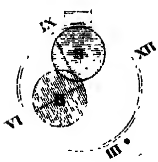
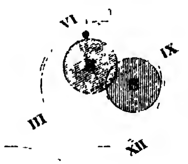
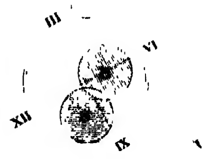





Fig. 9 Fig. 10 Fig. 11 Fig. 12

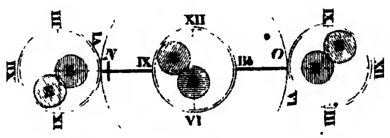


Fig. 13

G. Harvey delin. Edin. Published by A. Constable & Co. 182[illegible] W. H. Lizars sculp.

This circumstance, taken in conjunction with some other phenomena which I have lately noticed, would seem to countenance the opinion, that the influence of magnetism is sometimes only of a temporary kind; and that a chronometer frequently returns to its original rate, as soon as the exciting cause is removed. In a great number of instances, I have found the change of rate to have been immediate, both from a considerable gaining rate to one of a great diminution; and, on the contrary, from a great decrement to a large increment. It would be an interesting question to determine, if the sea and land rates of chronometers are, in the generality of cases, immediately acquired. From the few observations which I have had an opportunity of making, this would seem to be the case; and Mr Fisher, in his interesting paper in the Philosophical Transactions for 1820, seems almost to countenance the idea.

PLYMOUTH,
October 10. 1823.

ART. II.—*Description of the Whirlwind at Scarborough on the 24th June* 1823. By JOHN DUNN, Esq. Fellow of the Royal College of Surgeons, London. Communicated by the Author.

THE extraordinary, and to many even alarming, meteoric phenomenon which occurred at Scarborough in the afternoon of the 24th of June, induced me to make every exertion in collecting such facts respecting it as could be depended upon. The various conflicting accounts which I received from above twenty witnesses, have been carefully balanced together; and although I had only the good fortune to observe its effects, yet the materials I now present to you will, I trust, be found tolerably accurate.

After a fortnight of very boisterous, and, for this period of the year, extremely cold weather, the wind having kept steadily to the N. and NE., and the thermometer as low as 53° Fahr., a thunder-storm burst from the west at a little before 3 in the afternoon. One of the reports was very loud, and awfully

grand; the lightning, however, did no mischief, and the rain was soon over. After the expiration of ten or fifteen minutes, and during the calm which supervened, some persons sitting on the lofts of a manufactory on the sands were struck with the singular appearance of the clouds. They remarked a heavy cloud, descending from the SW., and a lower one. scudding from the NE., attract and strike each other with great energy,—the surrounding clouds rushing in a whirl to the same centre, and then rebounding. This scene of elementary confusion instantly arrested the notice of all the workmen. The whole mass of clouds was observed to be in violent agitation; an upper dense and dark stratum seemed to be pressing a lighter one down to the earth. They were then blended in one dense column, which descended to the ground, passed from the field of Mr Tindall in a direction from the W.NW., over the hedge which forms one of the boundaries of the plantation walk. Its force was here so great, that it levelled two very fine elms of about four feet in girth, one being torn up by the roots, and the other broken off at the surface of the ground. The thorns and some intervening trees escaped unhurt, although a considerable fissure was observed in the ground, which must have been occasioned by the disturbance of the roots from the impetuosity of the wind. The space between the two fallen trees, according to my measurement, was 28 paces, which, I conceive, will give some idea of the extent at that time of the lower portion of the whirlwind; for the trees having fallen across the walk, it must have struck parallel with the fence. It now passed across the young plantation on the other side, shook the trees most violently, but did no farther mischief than breaking off the summit of one of them, which I attribute to the great elastic power of these young trees, and the less surface of resistance which their branches would present. The cloud continued its march in majestic grandeur across the road, passed some labourers at the waterfall below the terrace, tore up some cabbage-plants in a garden on the left, went over Ramsdale height to the sands, drove a machine containing a camera obscura into the sea, and dashed it into a hundred pieces. It now made a direct course to the east, scattering the sand to the height of 60 feet, which almost blinded a person who was running from the precarious shelter

he sought in a bathing machine; the whole line of these carriages was turned over upon their broadside, and the tide being up, they were driven into the sea, some without their roofs or wheels. The scene became now highly animated and impressive. The pedestrians on the pier, with that energy inspired by fear and the approach of danger, were seen making their escape as they could. Some of my acquaintances enjoying their wine in a cabin of one of the vessels, between the piers, were suddenly alarmed by the boy rushing down from the deck, and crying out "The bathing-machines are running into the sea, many have turned over, and some heels-over-head." Their vessel in an instant broke its anchorage, and turned over on its beam ends, to the no small destruction of their glasses and Falernian.

The tornado being now between the piers, having passed over a considerable surface of the tide, had driven the water in foam and spray to the height of the ship's topmast. After making much havoc among the light boats,—raising one 8 or 10 feet out of the sea,—staving, upsetting, and filling others with water,—turning the brig just mentioned upon its beam ends, and which but for the pier would have been upset,—and forcing three other vessels from their moorings,—it passed through the harbour, drove round, with great velocity, a large crane, and, carrying away a basket, an umbrella, and other light bodies, was at length broken by a heap of timber, and rising over the battery in rapid volutions, whirled into the clouds and disappeared.

Your inquiries in a former Number (No. IX. p. 41.) on these phenomena, I shall now endeavour to answer to the best of my means of information. From the immense quantity of water and foam scattered about, and from the violent agitation of the waves beneath, many experienced seamen had deemed it a water-spout. It left no trace of water, however, when it first passed over the land, but seemed a dense column of vapour, performing very rapid and violent revolutions around its axis. The sea was evidently taken up by the energy of the rotatory motion of the winds: its surface was not at all agitated till the column passed over it, and the water carried up was not in a solid cone, which it would have been had there been a vacuum, but in spray and foam. The persons who saw the water-fall have no doubt it was from the sea, and are persuaded, from the im-

petus of the propelling power, that it would have carried up even small fish, or any other light body, in its way. It was quite perpendicular, and seemed at first to be thicker at the summit than below, resembling a trumpet. Its density was so great, that many persons thought it was the smoke of some fire on the sands, but the most compared it to the steam from a large brew-house or steam-engine. The gyrating motion resembled a screw or the *Cornu ammonis*, and with this exception, and a more bulging character near the clouds, many respectable witnesses have assured me it was very much like the drawing in Vol. V. Plate I. Fig. 1. *b*, of the *Edinburgh Philosophical Journal.* I can get no precise idea with regard to its velocity, some persons believing it travelled with less speed than they could run, others thinking they could not have kept pace with it. By comparing the time of its duration with the ground it passed over, which must have been at least half a mile, we may arrive at some approximation to the truth; and although I have been told by some it was not seen for more than three, and others for ten minutes, when I consider that all agree in thinking themselves able to have got out of its reach, I should be inclined to believe that its course would have been at about seven miles an hour.

The noise was very peculiar, and brought many people to their windows to see what was the matter. Some describe it as imitating the roaring of a great wind; some a crackling noise like a house on fire; a military gentleman informed me it resembled the explosion of a mine under water; but the majority considered it like the rumbling of heavy carriages. Another variation from the account given of a former one in your Journal, is, that the water was certainly not agitated till touched by the column; and although the foam was not less than 80 yards in diameter, and reached the ship's topmast, about 70 or 80 feet in height, the sea at a very small distance was as tranquil as usual. The altitude of the column of wind varied; and as, in the hurry of such a moment, no one would have an instrument to measure the angles with, considerable differences of opinion on this point prevail. There seemed to be a conformity of sentiment that clouds were never seen so low before as those from whence this meteor proceeded. There was no discharge of light either above or below, nor sound like that of a sudden and momentary explosion,

but the noise was a continued roar: a faint stream, resembling thin vapour, was, however, perceived descending from the cloud above.

The thermometer rose that day to 58°, where it has remained with very little variation since. The barometer I noted, ten or fifteen minutes after the hurricane, at $29\frac{1}{2}$. It fell on the 29th to $29\frac{1}{4}$, but since the subsequent storm it has risen to $29\frac{3}{4}$. The opposing currents of wind were remarkable; the *lower* stratum after coming a little while on Thursday evening from the W.SW., again shifted to the N.NE.; but the clouds *above* still continued to pass from the S.SW. This opposite state of the wind existed till Sunday the 29th, the weather remaining dry, with some occasional deviation, and fans and streamers pointing in different directions, according to their elevation, when a storm of thunder of unwonted energy burst over our heads from the W.SW. about 1 P. M. The lightning was most vivid, and accompanied with heavy showers of hail. About an hour after the storm, the barometer began to rise, but the clouds continued to come from the *SW.*, whilst the weathercocks on the church and in the town stood in the *NE.*, as they had done in the morning. The atmosphere became very warm, and the wind again setting E.NE., we had soon clear and settled weather for the first time these three weeks.

The cause of these phenomena, as explained by Franklin, seems to be contrary to the known laws of pneumatics. How could a vacuum preserve itself one moment against the superincumbent pressure of the atmosphere? * Besides, if the water had been raised in one continued column, it could not have ascended higher than 32 feet. Capper, on "Winds and Monsoons," explains it in a similar manner; but the necessity of a vacuity is by no means clear to me, as the impetus of the gyrating motion of the wind is quite sufficient to take up water in its whirls. Darwin imagined that it may be produced by a cold stratum of air descending and displacing a lower one of higher temperature; but the extreme cold of the earth's surface which we have endured of late, renders this theory equally improbable as a primary cause, for a fire on the ground should be followed with

* See the Honourable Captain Napier's Paper on Waterspouts in this *Journal*, Vol. VII. p. 99.—ED.

more violent effects. Impenetrable as the arcana of Nature seem to be, the eye of the philosopher must turn to electrical science alone, veiled as she is in darkness and uncertainty, for a true explanation. The connection of electricity with galvanic, magnetic, and chemical attraction,—its universal agency in pointing the thunderbolt, as well as in forming a drop of water, unequivocally elevate it, as far as finite search can reach, to the dignity and station of first causes. Kirwan observes, that "winds appear to begin at that point towards which they blow." Hence we may easily suppose the operation of this powerful agent acting in one common centre, in the opposite currents of wind; the violent and instantaneous agitation of the clouds,—their rapid attraction and repulsion from one common point,—their sudden descent from this centre to the earth,—their partial influence on the waters below; the whole immediately following a thunder-storm of undoubted electrical origin, and taking the same direction from the west with both that and the violent storm a few days afterwards

Dr Franklin's opinion of the identity of water-spouts and whirlwinds, is strongly corroborated by the instance before us. The ancients seem also to have considered them modifications of each other. Lucretius thus describes the *prester* or water-spout:

"For as the cone descends, from every point
A dread tornado lashes it without,
In gyre perpetual, through its total fall:
Till, ocean gained, the congregated storm
Gives its full fury to th' uplifted waves,
Tortur'd and torn, loud howling midst the fray.
"Oft, too, the whirlwind from the clouds around
Fritters some fragments, and itself involves
Deep in a cloudy pellicle, and close
Mimics the prester, length'ning slow from heaven;
Till, earth attain'd, th' involving web abrupt
Bursts, and the whirlwind vomits, and the storm," &c. &c.

Good's *Translation.*

As the thunder-storm on the 29th was unusually severe, and as it is somewhat connected with my subject, for I am convinced it settled the unseasonable state of the weather, I perhaps may be excused in detailing its effects on a house which it struck, in the occupation of my friend Mr Greave. This building faces the south; the tempest came from the S.SW.; the lightning

was seen to strike it near the centre. Without injuring either the brick-wall or window, which was shut, and through which it must have obliquely passed, it struck the screw of the upper bed-post, ascended the pillar, shivered it into numerous splinters, some of which still hung horizontally by small portions slightly attached. It then passed along the bell-wire at the head of the bed to the first turn, which it left, and descended in a zigzag direction, splitting open the paper from the wall, to the apartment below. It now took another bell-wire, and sent off a portion over the face of a looking-glass, without doing any injury farther than tearing the paper below as before. The remaining stream proceeded to the corner, and gave off another portion which tore the paper down to the moulding. The original line still continuing along the bell-wire, made its last turn, went down the wall, splitting open the paper, leaped over a miniature, and again tearing away the paper and plaster underneath, disappeared at the fire-place. The maid-servant hearing a little dog screaming violently, ran into the apartment, where she saw a blaze as if it was on fire. The room was full of smoke of sulphureous odour. She was instantly knocked down as from an electrical machine, and felt as though on fire. On attempting to rise, she was so benumbed as to fall again; but at length she succeeded in getting up stairs, where she found the bed-chamber as full of smoke as the last. She screamed out, and endeavoured to sit down. When she was well enough to reach the outer door, she was much relieved, but complained of soreness, stiffness and swelling of the throat, headache, and great numbness of the limbs. In the evening her numbness was subsiding, her tongue very dry, and the throat shewed no signs of inflammation, although it still felt very sore; her neck was stiff, and although it had been covered at the time with a silk handkerchief, was marked with several red lines, as if scorched or struck with a cane: the same appearances were observed in her legs. Notwithstanding she was much better the next day; she had not yet been able to taste food, was very thirsty, and a little feverish, the soreness of the skin gradually disappearing. The dog was not injured, probably from the non-conducting properties of his coat. No perforation could be discovered through the walls,

nor any traces of fire or charring could be found in the course of the electrical fluid. The upper and lower winds, after continuing a little while from SSW. and NNE., have since blown uniformly from the E.NE., and the weather is now quite settled.

Scarborough, Yorkshire,
July 1823.

Art. III.—*Observations on the Heights of the Himalaya Mountains, with the Measurements of Lieut. A. Gerard and Mr J. Gerard.* By William Lloyd, Captain of the Bengal Army.

In the fourteenth volume of the Asiatic Researches, printed at Calcutta, there is a memoir of great interest on the heights of the principal Snowy Peaks of the Himalaya Mountains, by Captain J. A. Hodgson and Lieutenant J. D. Herbert; and it is really lamentable to observe in a work of such deserved reputation, and which is so widely circulated, the numerous errors of the press that in a particular manner mark that paper. A brief extract of that memoir has just been published in the Eighteenth Number of the Edinburgh Philosophical Journal, with a table of the general results of those valuable, extensive, and laborious operations; which, although correctly copied from the Calcutta edition of the Asiatic Researches, does not exhibit the true heights of the Snowy Peaks, and which is calculated to confound the stations of the Great Triangulation with the Peaks themselves. At page 312 of the Calcutta edition of the Researches (14th volume), there is a table designated "Snowy Peaks, with data." It is from this table that the heights of a number of the Snowy Peaks above the level of the sea have been extracted. The table commences "Uchalaru, F." which signifies that the Snowy Peak marked F. in the Plan of the Triangulation, is seen from the station of Uchalaru under an angle of 5° 40′ 25″, is distant from it 76,673 feet, is 7,742 feet higher than Uchalaru, and, finally, 21,884 feet above the level of the sea. Again, "great E.," which is one of the peaks of Jumnooturu, is seen from Uchalaru under an angle of 9° 34′ 55″, is distant from it 39,037 feet, is elevated 6,623 feet above

it, and rises 00,765 feet above the ocean. Kedar Kanta is another lofty station of the great triangulation, and the table shews the difference of level between it and the Snowy Peaks marked L. No. 39, great E. (one of the Jumnooturu Peaks), the middle and left peaks of the group H., the peak C., and the cone; their distances from it, and likewise their respective heights above the level of the sea. The Chur station is upon a stupendous mountain, from whence the Peak of Ralding, 363,580 feet distant, is seen under an angle of 1° 5′ 44″: this mighty peak, 21,251 feet above the level of the sea, stands on the left bank of the Settlej river, and beyond the hither Himalah, or that portion of the Snowy Chain that looks down upon the plains of India. This being a correct elucidation of Captain Hodgson's table, the impropriety of connecting the stations of the triangulation with the peaks in a "table of the heights of the Snowy peaks of the Himalaya Mountains" is evident, since it impresses the reader with the idea, that the station and peak together signify one and the same mountain, as in the instance Chur Ralding, Whartu pyramidal Peak, &c. &c. The heights of the Snowy Peaks above the level of the sea, given in the table of the "Snowy Peaks, with data," at page 312 of the fourteenth volume of the Asiatic Researches, and published in the Edinburgh Philosophical Journal, are erroneous, as appears from the note at the foot of page 316 of the Asiatic Researches, which cancels the list of results given in that table, and substitutes a new one at page 324, headed "Peaks of the Himalaya, or Snowy Range," to which a number of additional observations have been added. The reason stated in the note for cancelling the first table is, that the first calculations gave but 853 feet for the height of the station of Belville on the plains, above the sea, instead of 1013 feet, which it was found to be by subsequent and more complete barometrical observations, as detailed in page 320. The difference of 160 feet has been added to the mean heights given in the table of Snowy Peaks with data in the new table at page 324, which consequently exhibits the true heights of the principal Snowy Peaks above the level of the sea, and defines them past the possibility of mistake, by giving their latitudes and longitudes.

I have been induced to take the liberty of troubling you with

these remarks, from a conviction that you will, in the next number of your valuable Journal, insert Captain Hodgson's corrected table of the heights of the Snowy Peaks of the Himalah Mountains: and should the following results of observations, made in the same tract of country, by Lieutenant Alexander Gerard and Mr J. Gerard, be thought of sufficient interest, you are welcome to publish them also. These last observations have already appeared in the Calcutta Journal.

Heights by Barometer.

	Feet above the Sea.	
Shatool Pass, - -	15,554	
Boorendo Pass, - -	15,095	Buranda Páss of Captain Hodgson.
Keoobrung Pass, - -	18,448	
Pass between Soongnum and Manes,	18,743	Limestone.
Bed of the Sutlej under Bekhur,	10,792	
Highest birch-forest near Soongnum,	14,000	Tully.
Highest cultivation at Bekhur,	13,000	
Top of Choor Mountain, -	12,143	Chur of Captain Hodgson.
Station on Purgeool Mountain,	19,411	Purkgul of Captain Hodgson.
Highest night-camp, -	18,129	
Bekhur Village, - -	12,676	
Nako, - - -	12,005	
Shipki, - - -	10,597	Shipki of Captain Hodgson.
Shealkur Fort, - -	10,403	Shalkar of Captain Hodgson.
Huttoo, or Whartoo, -	10,656	Whartu of Captain Hodgson.
Ammonites found at -	16,000	
Highest sandstone, -	16,700	
Rampoor, - - -	3,398	
Soobathoo, - -	4,205	Sabhatu Math of Captain Hodgson.
Dehra, - - -	2,349	
Suharunpoor, - -	1,093	Near Belville, Captain Hodgson.

Heights by Trigonometry.

Purgeool, or Tuzheegung Mountain,	22,488	Purkgul of Captain Hodgson.
Ruldung Mountain, - -	21,103	Ralding of ditto.
Budraj Mountain, - -	7,502	Bhadraj of ditto.
Bhyrat Fort, - - -	7,592	Bairat of ditto.
Limestone at least -	20,000	

LONDON,
October 1823.

In compliance with Captain Lloyd's request, we have inserted the following larger and more correct Table of the Heights

of the Snowy Peaks, with their longitudes and latitudes. We shall be glad to receive any farther communication from Captain Lloyd on the subject of the physical geography of India.

Corrected TABLE of the Heights of the Snowy Peaks of the Himalaya Mountains.

STATIONS.	North Latitude.	Longitude East from Greenwich.	Elevation above the Sea in English Feet.	District or State.
	° ′ ″	° ′ ″		
A, No. 1. - -	30 18 30	79 45 54	23,531	Jawahir.
A, No. 2. - -	30 22 19	79 57 22	25,749	Ditto.
P. or A. No. 3. -	30 30 42	79 51 33	23,317	Ditto.
J. - - -	30 43 33	78 48 35	17,017	Garhwal.
B. Middle Peak, -	30 44 01	79 16 05	23,441	Badrinath.
U. - - -	30 46 08	79 06 01	21,162	
D. - - -	30 47 36	79 03 11	23,062	
Q. - - -	30 47 55	78 50 10	19,928	
Q.–C. - -	30 48 55	78 49 52	19,530	
C. (Jaunli Peak), -	30 51 04	78 50 37	21,940	Jaunli.
M. Mount Moira, -	30 51 27	78 58 58	22,792	Ditto.
St Patrick, - -	30 51 38	79 06 41	22,798	Garhwal.
St George, - -	32 52 29	79 07 30	22,654	Garhwal.
F.–C. - -	30 52 46	78 51 26	21,772	Ditto.
The Pyramid, -	30 54 37	79 02 47	21,379	Ditto.
F. - - -	30 54 53	78 50 02	21,964	Ditto.
G. Sri Kanta, - -	30 57 12	78 47 33	20,296	Ditto.
Rudra Himaleh, -	30 58 18	79 05 40	22,390	Ditto.
Serga Ruen'r, -	30 59 25	79 05 35	22,906	Ditto.
Great E. or Banderpuch,	31 00 00	78 32 37	20,916	Ditto.
Low E. - -	31 00 11	78 30 39	20,122	Ditto.
Shippur, - -	31 00 30	79 00 57	18,681	Ditto.
Black E. - -	31 01 21	78 33 32	21,155	Gurhwhal.
H. Middle Peak, -	31 05 49	78 29 37	20,668	Ditto.
H. Right Peak, -	31 05 52	78 30 03	20,668	Ditto.
H. Left Peak, - -	31 05 55	78 29 15	20,501	Ditto.
Jhala Peak, - -	31 07 40	78 49 28	18,795	Ditto.
Tawara Peak, - -	31 08 21	78 48 53	19,352	Ditto.
The Cone or S. -	31 13 51	78 31 13	21,178	Garhwal & Bissaher.
Peak *a*, No. 39, left or high,	31 14 13	78 23 55	19,481	Ditto.
L. (No. 40), N. Western Peak,	31 16 04	78 22 25	19,512	Ditto.
No. 46. or Needle Peak,	31 19 45	78 18 19	19,044	Ditto.
Ralding, - -	31 29 22	78 21 44	21,411	Ditto.
Rishi Gangtang, -	31 37 20	78 36 10	21,389	Ditto.
Western F. - -	31 41 18	77 44 06	18,798	Kullu and Chamba.
Purkyal, - -	31 53 17	77 43 52	22,700	Bissaher.

Art. IV.—***Observations on Bees, and particularly on the conversion of the Larvæ of Working-Bees into Queen-Bees.*** **By the Reverend Mr Dunbar of Applegarth. Communicated by the Author.** *

Among my experiments in the year 1822, there were two rather of an interesting nature, one of them confirming beyond the possibility of a doubt, the remarkable and often-questioned fact in the natural history of bees, of their having the power of converting the larva of a working-bee into a queen, when circumstances require such an expedient;—the other experiment is completely practical in its nature, and the consequence of the one first mentioned.

Experiment I.—In a communication inserted in the Philosophical Journal, I mentioned an instance which I had witnessed of the formation of a queen from the egg of a working bee;—a discovery for which Natural History is indebted to Schirach, and which had been repeatedly verified by the celebrated Huber. Possessing a hive extremely well fitted for experiments of this kind, and which I have named the *Mirror-Hive*, from its exact resemblance to that piece of household furniture, I set about repeating this experiment in such a way as to put the matter out of all doubt. Huber had already done this so accurately that no person at all conversant in this branch of natural history could reasonably have felt any hesitation on the subject, provided there was no favourite theory to be upheld. But Huber was a foreigner, and I have heard it alleged against him by some, that he was a man of a very vivid imagination,—and by others, that being defective in his eye-sight, he had given credit on the word of his assistant to reports of discoveries unfounded in fact. Huish, an Englishman, has published a Treatise on Bees, in which he treats with much petulance and ridicule the theory of the formation of artificial queens, so warmly supported by Huber; and I observe in the London list of new publications, a pamphlet announced by him in answer to my paper on that subject in this Journal. The following results of an experiment I made last summer, will, I presume, be regarded as a conclu-

* Read before the Wernerian Natural History Society, 15th November 1823.

have answer to his objections, and to those of any others who may be sceptical on the point.

In July the Mirror-Hive was full of comb, bees, brood, and honey,—the queen very fertile, and laying at the rate of 100 eggs *per diem*. I opened the hive and took her away. For eighteen hours they continued to labour as if she were still with them; at the end of that time they missed her, and all was instantly agitation and tumult; the bees hurried backwards and forwards over the comb with a loud noise, rushed in crowds to the door, and out of the hive as if they were swarming, and, in short, exhibited all the symptoms of bereavement and despair. Next morning they had laid the foundation of five queen cells, having demolished the three contiguous cells to the one containing a worm which suited their purpose, and by the afternoon four more, all in parts of the comb where before were nothing but eggs and common worms of one or two days old. Two of these royal cells advanced more rapidly in size than the rest, probably from the larvæ being of an age fittest for the purpose; four came on more slowly, and three made no progress after the third day. On the seventh day the two first were sealed, two more were nearly so, all the rest continued stationary, and in fact remained so, as if the bees, satisfied that they had at least secured one queen, did not think it necessary to carry forward the others to maturity. On the morning of the fourteenth day from the removal of their old queen, a young one emerged from her cell, strong, active, and exactly resembling those produced in the natural way. While examining her motions, I saw her hasten to the other royal cell, which had been closed about the same time with the one from which she had come, and attempt to tear it open, doubtless with a view of destroying its inmate; but the working-bees pulled her away with violence, and continued to do so as often as she made the attempt. At every repulse, she stood, in a sulky posture apparently, on the comb, and emitted the shrill *peep peep*, so well known to bee-masters, while the unhatched queen at the same time sent forth a peep also, but of a hoarser kind. And this accounts for the two different sounds which are generally heard in the evening from a hive about to throw a second swarm. The shrill sound proceeds from the reigning queen, and seems to express her rage

and disappointment at being baffled by the watchful guardians of the unhatched queen, from whom the hoarse sound comes. In the afternoon of the same day the last mentioned female left her cell. I saw her come forth in majesty, finely and delicately formed, but smaller than the other. She immediately retired within a cluster of bees, and I lost sight of her. Next morning, on opening the shutter of the hive, I perceived the youngest queen rushing apparently in great terror over the face of the comb, and turning round the edge of it to the other side; and in the next moment the other queen was seen pursuing with equal rapidity. I now fully expected to witness Huber's combat of queens, and was about to wheel round the hive on its pivot, to inspect their proceedings on the other side, when business called me off. I returned in half an hour, thinking I might yet be in at the death, but found all was over! The young queen was lying on the alighting-board on her back, in the pangs of death, newly brought out by the bees, and doubtless the victim of the elder queen.

I observe two circumstances respecting this last queen, one of which agrees perfectly with the experience of Huber, while the other is at variance with it. While the young queen remained a virgin, not the slightest respect was paid her by the bees; not one gave her food, she was obliged to help herself, and in crossing towards the honey-cells, she had to scramble over the crowd, not an individual of which would get out of her way, or seemed to care whether she fed or starved. But no sooner did she begin laying than the scene was changed, and complaisance, respect and attention, became the order of the day; one after another extended the proboscis with food, and at every step of her progress a circle was formed round her by her admiring people. The other circumstance, and which varies from the experience of Huber, respects the sound emitted by the queens. He says that the workers form no guard around the cells of artificial queens,—that these are perfectly mute, and he makes several remarks by way of accounting for it. The above experiment completely contradicts this. The cell of the young queen was guarded most vigilantly, and both emitted the sounds alluded to, perhaps once every minute, for several hours together.

Experiment II.—This experiment, which was entirely practical, and consisted in turning to account the result of the first experiment, respected the formation of artificial swarms, an expedient, in my opinion, never to be resorted to, but in such cases of necessity as that I am about to detail. From the first to the third week of June my hives had all thrown their top-swarms; but instead of throwing their second in ten or twelve days thereafter, as is generally the case, four of them had not cast nearly three weeks after. This was probably owing to the unfavourable state of the weather, which, by delaying the swarming, had furnished the reigning queen with an opportunity of putting to death one or two of her intended successors. In these circumstances, from the crowded state of the hive, a mass of bees as large as a man's head hung from the alighting-board of each hive; a sight grievous to the Apiarian, as these outliers are quite idle. Determined to avail myself of Schirach's and Huber's discoveries, I cut out of the Mirror-hive a piece of comb about three inches square, containing eggs and worms, and fixed it in an old hive full of empty comb. I then removed out of sight one of the hives which had an outlying, or rather outhanging, mass on its alighting-board, instantly clapped down in its place on said board the empty hive, and forced the idlers to enter. They made a tremendous noise, and seemed disconcerted at finding, instead of the rich combs they had hitherto been familiar with, nothing but empty cells. This agitation was kept up all day by the continued arrival of the bees belonging to the original hive, who had been abroad when their habitation was changed, and who now added greatly to the population. At noon next day I inspected the new establishment (a leaf-hive of Huber), and found, to my satisfaction, the foundations of three queen-cells laid in the small piece of brood-comb I had given them. In due time a queen was hatched,—the hive prospered, and at the end of the season I took from it four and a half pints of honey. Finding this trial succeed so well, I instantly fell to work with two more in similar circumstances, and with the same success. One of these died about a month after, but from causes which had no connection with the experiment; the other I kept over winter, and it has now swarmed, (July 1. 1823).

I had still another which hung out, and from this also I forced a cast, but by a method which has been often adopted by others. I carried the full hive into a dark place, turned it up, placed an empty hive over it, mouth to mouth, and *drove* it partially. Perceiving that half the bees had gone up, and knowing that in these cases the queen is always among the foremost, I immediately replaced the old hive in its former station, and carried the new one, containing the queen, to a little distance. As the old hive had plenty of eggs and young brood, the bees were at no loss to procure another queen; and the new one having a queen, proceeded to work in all respects as a natural young swarm. The old one I kept over winter, and it cast this summer.

ART. V.—*On the Refractive and Dispersive Power of different Species of Glass, in reference to the improvement of Achromatic Telescopes, with an Account of the Lines or Streaks which cross the Spectrum.* BY JOSEPH FRAUENHOFER of Munich. Concluded from Vol. IX. p. 299.

As the lines of the spectrum are seen with every refracting substance of uniform density, I have employed this circumstance for determining the index of refraction of any substance for each coloured ray. This could be done with the greater exactness, as most of the lines are very distinct and well marked. For this purpose, I selected the largest lines, because with substances of low refractive power, or with prisms of small refracting angles, the lines of less magnitude could scarcely be perceived with a strong magnifying power. The lines which I chose were those marked B, C, D, E, F, G, H, in Fig. 5. of Plate VII. (Vol. IX.) I made no use of the line *b*, because it is too near F, and I endeavoured to use the middle one between D and F. It is not practicable to measure large arcs, such as BH, but only small ones like BC, CD, because, in order to see the lines of the different colours distinctly, the eye-glass requires to be displaced.

The following Table contains the measures of the angles obtained from different kinds of glass, and other refracting substances.

Refracting Media.	Temp. Reaum.	Spec. Gravity.	Angle of the Prism.	Angle of Deviation. μ.	BC	CD	DE	EF	FG	GH
Flint glass, No. 13.	15°	3.723	26° 24′ 30″	17° 27′ 8″	3′ 16″	9′ 4.2″	11′ 50″	10′ 33.9″	20′ 23.9″	18′ 18″
Crown glass, No. 9.	14	2.535	39 20 35	22 38 19	2 44.5	7 23.5	9 14	8 14	15 10	13 18
Water, -	15	1.000	58 5 40	22 36 40	3 24	8 10	9 58	8 38	15 16	12 41 9
Water, -	15	1.000	58 5 40	22 36 40	3 12.4	8 10.6	9 57.5	8 30.5	15 15.6	12 46.2
Kali dissolved in water,	9	416	58 5 40	27 45 56	4 2	10 26	12 54	11 12	20 36	17 24
Oil of Turpentine,	8½	0.885	58 5 40	33 20 12	4 56	13 52	18 46.1	16 14	31 8	27 28
Flint glass, No. 3.		3.512	27 41 35	17 35 16.6	3 8	8 22	10 46	9 50	19 10	17 10
Flint glass, No. 30.		3.695	21 42 15	14 3 9	2 35.6	6 56.8	9 12.6	8 19	16 15.6	14 32.2
Crown glass, No. 13.		2.535	43 27 36	25 26 35.4	3 5	8 14.4	10 28.2	9 10	17 14.8	14 48.4
Crown glass, M.		2.756	42 56 40	26 39 13	3 32.8	9 37.6	12 29.8	11 1.6	20 53.6	18 17.4
Flint glass, No. 23.		3.724	60 15 42	49 55 13.2	11 12.6	31 14.8	41 21.4	38 14.8	1 14 45.2	1 8 3.6
Flint glass, No. 23.		3.724	45 23 11	32 45 12.2	6 26	17 47.8	23 31.8	21 23.8	41 33.4	37 28.8

In order to measure these angles, I employed the same theodolite which I have already mentioned. The measures were taken six times. The distance of the theodolite from the window of the dark room into which the light entered, was only 24 feet. The correction of the angle μ arising from the distance 4.25 inches of the prism from the axis of the theodolite, would have been very considerable. In order to avoid the uncertainty which arises from a great correction, I determined the angle μ for the light of a lamp, as the rays D, Fig. 5, and R, Fig. 4. Plate VII, Vol. IX., have the same refrangibility. In this case the lamp was at a distance of 692 feet; the correction of μ was

very small; and, with the prism with which I made these experiments, it was only 40″.5 for *water*. I have measured, then, only the arcs BC, CD, DE, &c. The corrections are small, and consequently very exact. With the prism they amounted, for BC only to 2″.5, for CD to 6″.5, and for DE to 8″. All the angles in the preceding Table have received this correction. Calling σ the angle of the incident ray, ϱ the angle of the emergent ray, ψ the angle of the prism, and n the index of refraction, we obtain

$$n = \sqrt{\left[\frac{(\sin \varrho + \cos \psi \sin \sigma)^2 + (\sin \psi \sin \sigma)^2}{\sin \psi}\right]}.$$

If the angle of the incident ray is equal to the angle of the emergent ray, and if μ is the angle which the incident ray forms with the emergent ray, we shall have

$$n = \frac{\sin \frac{1}{2}(\mu + \psi)}{\sin \frac{1}{2}\psi}.$$

This last expression for n will not be rigorously correct in substances with a great dispersive power, and for an emergent ray, the angle of which is not equal to that of the incident ray, for the latter cannot be so, excepting to only one of the emergent rays, such as that at D, on the supposition that the prism does not change its place. In making use of the last Formula for calculating the indices of refraction with great accuracy, I only measured the arcs BC, CD, DE, &c. when the distance of the two lines was the smallest. But this distance corresponds only to two lines of the spectrum, if a ray in the middle of them makes the smallest angle with the incident ray. When I measured, for example, the arc GH, the place of the prism was such, that a ray, nearly in the middle between G and H, formed the same angle with the prism that the incident ray did. The prism has this position when the angle of refraction of this mean ray is a minimum. By the help of the telescope, and by turning the plane on which the prism rests, this position may be easily found with the greatest exactness. With substances of a less dispersive power, or with prisms of a smaller angle, the same care is not requisite to obtain this degree of accuracy. Calling E n the index of refraction for the ray E, we have

$$En = \frac{\sin \frac{1}{2} (\mu + \psi + DE)}{\sin \frac{1}{2} \psi},$$

and for the ray F,

$$Fn = \frac{\sin \frac{1}{2} (\mu + \psi + DE + EF)}{\sin \frac{1}{2} \psi}.$$

The following Table contains the indices of refraction for the different coloured rays in each refracting substance.

Refracting Media.	Bn	Cn	Dn	En	Fn	Gn	Hn
Flint glass, No. 13.	1.627749	1.629681	1.635036	1.642024	1.648260	1.660285	1.671062
Crown glass, No. 9.	1.525832	1.526849	1.529587	1.533005	1.536052	1.541657	1.546566
Water, -	1.330935	1.331712	1.333577	1.335851	1.337818	1.341293	1.344177
Water, -	1.330977	1.331709	1.333577	1.335849	1.337788	1.341261	1.344162
Kali, -	1.399629	1.400515	1.402805	1.405632	1.408082	1.412579	1.416368
Oil of Turpentine,	1.470496	1.471530	1.474434	1.478353	1.481736	1.488198	1.493874
Flint glass, No. 3.	1.602042	1.603800	1.608494	1.614532	1.620042	1.630772	1.640373
Flint glass, No. 30.	1.623570	1.625477	1.630585	1.637356	1.643466	1.655406	1.666072
Crown glass, No. 30.	1.524312	1.525299	1.527982	1.531372	1.534337	1.539908	1.544684
Crown glass, M.	1.554774	1.555933	1.559075	1.563150	1.566741	1.573535	1.579470
Flint glass, No. 23. Prism of 60°,	1.626596	1.628469	1.633667	1.640495	1.646756	1.658848	1.669686
Flint glass, No. 23. Prism of 45°,	1.626564	1.628451	1.633666	1.640544	1.646780	1.658849	1.669680

The following Table contains the ratios of the different dispersive powers of the differently coloured rays, in several combinations of the refracting substances, according to the results in the preceding Table.

Refracting Media.	$\frac{Cn' - Bn'}{Cn - Bn}$	$\frac{Dn' - Cn'}{Dn - Cn}$	$\frac{En' - Dn'}{En - Dn}$	$\frac{Fn' - En'}{Fn - En}$	$\frac{Gn' - Fn'}{Gn - Fn}$	$\frac{Hn' - Gn}{Hn - Gn}$
Flint glass, No. 13. and Water,	2.562	2.871	3.073	3.193	3.460	3.726
Flint glass, No. 13. and Crown glass, No. 9.	1.900	1.956	2.044	2.047	2.145	2.195
Crown glass, No. 9 and Water,	1.349	1.468	1.503	1.560	1.613	1.697
Oil of Turpentine and Water,	1.371	1.557	1.723	1.732	1.860	1.963
Flint glass, No. 13. and Oil of Turpentine,	1.868	1.844	1.783	1.843	1.861	1.899
Flint glass, No. 13. and Kali,	2.181	2.338	2.472	2.545	2.674	2.844
Kali and Water,	1.175	1.228	1.243	1.254	1.294	1.310
Oil of Turpentine and Kali,	1.167	1.268	1.386	1.381	1.437	1.498
Flint glass, No. 3, and Crown glass, No. 9.	1.729	1.714	1.767	1.808	1.914	1.956
Crown glass, No. 13. and Water,	1.309	1.436	1.492	1.518	1.604	1.651
Crown glass, M. and Water,	1.537	1.682	1.794	1.839	1.956	2.052
Crown glass, M. and Crown glass, No. 13.	1.174	1.171	1.202	1.211	1.220	1.243
Flint glass, No. 13. and Crown glass, M.	1.667	1.704	1.715	1.737	1.770	1.816
Flint glass, No. 13. and Crown glass, M.	1.517	1.494	1.482	1.534	1.579	1.618
Flint glass, No. 30. and Crown glass, No. 13.	1.932	1.904	1.997	2.061	2.143	2.233
Flint glass, No. 23. and Crown glass, No. 13.	1.904	1.941	2.022	2.107	2.168	2.268

The preceding Table shews the difference of dispersion relative to differently coloured rays for each combination of refracting substances. For example, for *flint-glass*, No. 13. and *water*, the ratio of dispersion of the rays in the space BC, is as 1 to 2.56, and of the space GH as 1 to 3.73. As these differences, however, are very small in some substances, as in *flint-glass*, and *oil of turpentine*, we may expect, with some confidence, that, in varying the ingredients, we may obtain a kind of glass, in which the differences will be smaller than in that which has hitherto been employed. The crown-glass M, for example, is of such a composition.

Calling 1 the aberration of an object-glass of *crown-glass*, No. 9., and *flint-glass*, No. 3., produced by the difference of dispersion relative to the different colours, this aberration becomes about 0.57 for an object-glass of the same focus, and composed of *crown-glass*, No. 9., and *flint-glass*, No. 13. It will be 0.52 for an object-glass of *crown-glass* M, and *flint-glass*, No. 13. and 1.74 with *crown-glass*, No. 9, and *crown-glass* M. In calculating these aberrations, I have taken into account the relative intensities of the differently coloured rays, of which I have already spoken.

The results given by two prisms of flint-glass, No. 23. shew the degree of confidence which may be placed in the measured angles. With the prism of 45° made of this glass, a change of an arc of 2″ produces a change of 1 in the 5th decimal of the index of refraction. With a prism of 60°, it requires an angular change of 3″.5 to produce the same variation in the decimal.

If in achromatic object-glasses, the aberration produced by the unequal refrangibility of the differently coloured rays ought to be destroyed, then, since the focal lengths of the lenses of flint and crown glass ought to be nearly in the ratio of the dispersion of the two kinds of glass; and since, on the other hand, the ratio of dispersion for the different colours is not the same, it is evident that some aberration must still remain; and we must therefore determine this ratio, in order that this aberration may be a minimum for the distinct vision of objects. This cannot take place, if the difference between the focal lengths for the rays of different refrangibility in the same object-glass is a minimum, for the different colours have not the same intensity: the aberration of the yellow rays, for example, which

have the greatest brightness, will produce in the ratio of their intensity a worse effect than the violet ones, if the aberration for the latter is of the same magnitude. Hence, we must know the intensity of each colour in the spectrum, or in what ratio the impression of any colour of the spectrum is stronger or weaker than that of another colour. In order to measure this intensity, I constructed the following apparatus.

To an eye-glass constructed for that purpose for the telescope of the theodolite, I applied a small plain metallic mirror, the edge of which being well defined, cut the field of the telescope in the middle, as shewn at *a* in Plate II. Fig. 2. It was placed before the eye-glass E, at an angle of 45°, and at the place of the image formed by the object-glass A. The eye-glass E is pulled out till the edge of the mirror, which ought to be vertical, is distinctly seen. At the side of the eye-glass, and in a direction perpendicular to the edge of the mirror *a*, and to the axis of the telescope AE, I fixed a tube *c* B, cut in the direction of its length at *b*; and in this cut I placed a narrower and a shorter tube MN, Fig. 1., which crossed the larger tube *c* B perpendicularly. In this narrow tube was a small flame, in the axis of the larger tube, which was supplied with oil from an external vessel. The narrow vertical tube *b* Fig. 2., or MN Fig. 1., had in the axis of the larger tube a small round aperture, turned towards the mirror *a*, by which the light of the flame fell upon it. By this contrivance, we perceive, in half of the field, the mirror *a* illuminated by the flame, and in the other half, one of the colours of the spectrum formed by a prism placed before the object-glass A. The nearer the tube *b* is brought to *a*, the more will the flame illuminate the mirror, and consequently we can obtain, at the same time, an impression produced on the eye by the light of the mirror (as seen by the eye-glass), of the same intensity as that which is produced by a colour of the spectrum in the other half of the field. The squares of the distances of the flame from the mirror for the different colours of the spectrum, are then inversely as the ratios of their intensity. Though at first it appears difficult to compare the light of two different colours, yet it becomes easy by a little practice. The intensity of the light of the mirror approaches more to that of any colour in the spectrum, if at the same position of the eye-glass its vertical margin is less distinct. If the mirror is adjacent to a part

of the spectrum more or less illuminated, the edge of the mirror becomes, in both cases, more distinct; because, in the first case, the mirror appears to be placed in the shadow, and, in the second case, it is the colour of the spectrum that is found there. The experiment with the mirror is a little difficult and uncertain, if we perceive clearly the lines of the spectrum, because the brightest and the darkest lines touch one another almost in every colour. On this account, the aperture in the window-shutter is made so broad, that only the strongest lines are just visible, and the fine ones not at all. In place of the mirror outside of the shutter by which the light entered, I put a white plane surface illuminated by the sun, because by any imperfection of the mirror the light is irregularly dispersed, which renders the observations more dubious.

In order to vary the experiments, I at one time enlarged the round aperture before the flame, and at other times I contracted it. I placed also at the end *c* of the wide tube a piece of ground glass, through which the mirror received its light. In this case I measured the distances of the flame from the ground glass. To avoid all illusion, the aperture before the eye-glass ought to be small, and to be at the place where the principal rays, or the axes of the rays coming from the edge of the field, cut the axis of the telescope. With the prism of flint-glass No. 13, having an angle of 26° 24′.5, I obtained the following results. Though the experiments were made in clear weather, and at noon, I sometimes perceived, in the course of the observations, a slight change in the density of the light which the prism received. The differences in the four sets of experiments may have been partly owing to this change, and the flame may also have changed its intensity in the course of the observations. If we call the intensity of the light at the brightest part of the spectrum 1, we shall then have,

Experiment I.	Exp. II.	Exp. III.	Exp. IV.	Mean of Four Experiments.
Intensity of Light	Int. of Light	Int. of Light	Int. of Light	Int. of Light,
At - B = 0.010	0.044	0.053	0.020	0.032
At - C = 0.048	0.096	0.15	0.084	0.094
At - D = 0.61	0.59	0.72	0.62	0.64
Between D and E = 1.00	1.00	1.00	1.00	1.00
At - E = 0.44	0.38	0.61	0.49	0.48
At - F = 0.084	0.14	0.25	0.19	0.17
At - G = 0.010	0.029	0.053	0.032	0.031
At - H = 0.0011	0.0072	0.0090	0.0050	0.0056

The brightest part of the spectrum is nearly at one-third or one-fourth of DE from D. Its position cannot be determined more exactly, nor is it of any great importance.

The curve in Fig. 5. Plate VII. Vol. IX. represents the intensity of the light in the different colours. The above values are the ordinates, and the measured arcs BC, CD, in the Table, p. 27., from flint-glass No. 13, the abscissæ. We may suppose that the quantity of the light in the different coloured spaces, is represented by the areas of the curve BC, CD. If we call this quantity 1 for the area of the space DE, then we shall have,

Area of BC =	0.021
CD	0.299
DE	1.000
EF	0.328
FG	0.185
GH	0.035

On the supposition that with an achromatic object-glass the aberration of the brightest rays is more injurious to distinct vision, in the ratio of their intensity, than the aberration of the fainter ones, the distinctness will be the greater if the ratio of dispersion, which we may call x, is taken, such that

$$x = b\beta + c\gamma + d\delta + e\epsilon + f\xi + g\eta \text{ *}$$

where β, γ, δ, &c. express the quantity of light in the spaces BC, CD, DE, &c., and b, c, d, &c. the quotients

$$\frac{Cn' - Bn'}{Cn - Bn}, \frac{Dn' - Bn'}{Dn - Bn}, \text{ \&c.}$$

This ratio is consequently for flint-glass, No. 30, and for crown-glass, No. 13, equal to 1 to 2.012. I have, however, found, that with the object-glasses of these two kinds of glass, the distinctness is a maximum, when this ratio is taken, equal to 1 to 1.98. This proves, that if the distinctness ought to be a maximum, the aberration of rays of least intensity ought to be greater than it is, in the inverse ratio of the intensity.

Having several object-glasses of the same aperture, the same focal length, and the same kind of glass, we may determine in

* In this case we have, $(x-b)\beta + (x-c)\gamma + (x-d)\delta + (x-e)\epsilon + (x-f)\xi + (x-g)\eta = 0$.

which of them the aberration produced by unequal refrangibility is the best compensated, if we cover one-half of each of them by a screen passing through the centre of the object-glass in a straight line. In those where the margin of a distant object is most distinct, the aberration is best compensated. In making this comparison, we must attend only to the distinctness of the object, and not be deceived by the colours, because one object-glass may shew less colour than another, and yet its distinctness be less. This detailed method of finding the best ratio of dispersion, is useful only for determining how much the aberration of the faintest rays ought to exceed that of the brightest rays. This result will be still more accurate if it is obtained by trials made with greater object-glasses, whose apertures are in the ratio of the greatest possible focal length. It is scarcely necessary to add, that the aberration of sphericity was corrected in all the object-glasses employed in these experiments. There is still another aberration which takes place in the eye itself, and to which we ought to pay attention, if we wish to find the best ratio of the colorific dispersion.

In placing the *red* colour of the spectrum in the middle of the field of the telescope of the theodolite, and in adjusting the eye-glass so as to be able to distinguish the fine micrometer wires, these wires will be no longer seen when the *violet* rays enter the field, the eye-glass remaining fixed. In order to see the wire in this colour, we must bring the eye-glass much nearer the wire; that is, more than double the aberration produced by the unequal refrangibility of the two kinds of rays in the eye-glass. This proves that the differently coloured rays in the eye have not the same focal distance, and that the eye is not achromatic *. The distance to which the eye-glass ought to be displaced in different colours, in order to see the wire distinctly, enables us to calculate this aberration in the eye, which is by no means small; but we must take into account the aberration produced by the eye-glass itself. It is scarcely necessary to state, that, in

* The want of achromatism in the human eye has been long ago pointed out by Dr Maskelyne, Dr Blair, and Dr Young. The last of these philosophers concluded, that the dispersive power of the eye collectively, is one-third of the dispersive power of crown-glass, at an equal angle of deviation. Mr Ramsden maintained the extraordinary opinion, that the separation of coloured rays is only observed

observations of this kind, no other light but that of the spectrum ought to enter into the field of the telescope, and that the wire should not receive any foreign light. I have found, with a lens of crown-glass, No. 13., with a focus of 0.88 Paris inches, that the eye-glass, in passing the wire from the ray C to G, ought to be displaced 0.054 of an inch, in order to see the wire with equal distinctness in both colours. A lens of crown-glass, No. 13., of 1.33 Paris inches focus, requires to be displaced 0.111 for the same colours; a lens of flint glass, No. 30., with a focus of 0.867, requires a displacement of 0.074; and another of flint-glass, No. 30., and a focus of 1.338, required to be displaced 0.148 of an inch. In these experiments, I looked with one eye at a fixed object, whilst with the other I observed at the wire through the lens, in order that I might be certain that, with the different coloured rays, the eye was always equally susceptible of uniting on the retina white rays of a given divergency; and, consequently, that it did not change, in that respect, for the different colours. Even with that precaution, however, the results did not differ greatly from the preceding.

The result given by the first lens is, that if the red rays fall parallel on the eye, the blue rays ought to diverge from a point 23.7 inches distant, in order to have in the eye the same focal distance. With the second lens this distance was 21.3; with the third 19.5; and with the fourth 17.9. In this calculation, I have taken into account the influence produced on this displacement by the unequal refrangibility of the two kinds of rays in the lens. This aberration in the eye cannot be fixed more rigorously, but by varied and repeated trials. It would be desirable to have the experiments repeated on the eyes of different persons, in order to obtain a mean result. In order to determine this aberration with still more precision, we must also take into account the diameter of the luminous cylinder formed

where there is no sudden change of density; and Dr Young has remarked, that if this hypothesis is well founded, the dispersion of the eye must be attributed wholly to the aqueous humour. Mr Ramsden's opinion is subversive of every principle in optics, and does not deserve to be refuted. Dr Brewster found that the dispersion of his eye, at the margin, when the pupil was about the seventh of an inch in diameter, was corrected by a prism of flint-glass of 10°, and having a dispersive power of 0.0478.—TRANS.

by the rays which go from the eye-glass to the eye. The diameter of this cylinder varies, and depends on the aperture of the object-glass, and the focus of the lenses of the eye-glass. It is easy to conceive that this aberration increases with the diameter of the cylinder. Great care is therefore requisite, in the calculation of object-glasses, to attend to the aberration of the eye, and to make it disappear from the object-glass.

If, in the calculation of achromatic object-glasses for the spherical aberration, we wish to make this aberration disappear entirely, the indices of refraction for the flint and crown glass ought to belong to the same coloured ray; for, if these indices belong to different rays, the aberration can never be extinguished, notwithstanding the most rigorous calculation. As the discovery of the lines in the spectrum enables us to determine these points with accuracy, they must be considered of great utility in removing this aberration.

Before the discovery of the lines in the spectrum, I determined the identity of the refracting powers of two kinds of glass, by cementing them together, and forming them into a single prism. If the two specula seen by this prism appeared on the same place, and without any reciprocal displacement, I concluded that their refracting power was the same. After the discovery of these lines, however, I found that two pieces of glass might still have a different refractive power, without that difference being perceived by the above method. This difference in refracting power was not only found in pieces of glass taken from different parts of the same crucible, but even in pieces taken from the two extremities of opposite sides of the same piece of glass. By repeated experiments on the manufacture of flint and crown glass, I have succeeded to such a degree, that, in a crucible containing 400 lb. of flint-glass, two pieces, one of which is taken from the bottom, and the other from the top, have the same refractive power.

In observing the great quantity of lines in the solar spectrum, we might be led to believe that the inflexion of light at the narrow aperture in the window-shutter had some connection with them, though the experiments described do not give the least proof of this, and indeed establish the contrary opinion. In order to put this beyond a doubt, and also to make some other observations, I varied the experiments in the following manner:

If we make the sun's rays pass through a small round aperture in the window-shutter, nearly 15″ in diameter, and cause it to fall on a prism placed before the telescope of the theodolite, it is obvious that the spectrum seen by the telescope can only have a very small width, and consequently will form only a line. In a line, however, of almost no breadth, it is impossible to see the fine and delicate lines which traverse it; and, on that account, the fixed lines are not seen in a spectrum of this kind. In order, however, to see all the lines in this spectrum, it is necessary only to widen it by an object-glass, without altering its length. I obtained this effect, by placing against the object-glass a glass having one of its faces perfectly plane, and the other ground into the segment of a cylinder of a very great diameter. The axis of the cylinder was exactly parallel to the base of the prism. The spectrum could not, therefore, change in its length, and was therefore only widened. In the spectrum thus altered, I recognized all the lines occupying the very same position that they had when the aperture was long and narrow.

I employed the same apparatus for examining, in the night time, the planet Venus, *without allowing the light to fall upon a small aperture.*

In the spectrum formed by this light, I found the same lines such as they appeared in the light of the sun. That of Venus, however, having little intensity compared with that of the sun reflected from a mirror; the brightness of the violet and the exterior red rays is very feeble. On this account, we perceive even the strongest lines in these two colours with some difficulty; but, in the other colours, they are easily distinguished. I have seen the lines D, E, *b*, F, Fig. 5. Plate VII., Vol. IX., very well terminated; and I have recognized that those in *b*, are formed of two, namely, a fine and a strong line. The weakness of the light, however, prevented me from seeing that the strongest of these two lines consisted of two; and, for the same reason, the other finer lines could not be distinguished. By an approximate measure of the lines DE and EF, I am convinced that the light of Venus is, in this respect, of the same nature as that of the sun.

With the same apparatus, I have also made several observations on some of the brightest fixed stars. As their light was much fainter than that of Venus, the brightness of their spectrum was consequently still less. I have nevertheless seen, with-

out any illusion in the spectrum of the light of Sirius, three large lines, which apparently have no resemblance with those of the sun's light. One of them is in the green, and two in the blue space. Lines are also seen in the spectrum of other fixed stars of the first magnitude; but these stars appear to be different from one another in relation to these lines. As the object-glass of the telescope of the theodolite has only 18 lines of aperture, these experiments may be repeated, with greater precision, by means of an object-glass of greater dimensions.

The electric light is, in relation to the lines of the spectrum, very different from the light of the sun and of a lamp. In this spectrum, we meet with several lines, partly very clear, and one of which, in the green space, seems very brilliant, compared with the other parts of the spectrum. Another line, which is not quite so bright, is in the orange, and appears to be of the same colour as that in the spectrum of the light of a lamp; but, in measuring its angle of refraction, I find that its light is much more strongly refracted, and nearly as much as the yellow rays of the light of a lamp. Towards the extremity of the spectrum we perceive in the red a line of very little brightness; yet its light has the same refrangibility as that of the clear line of the light of a lamp. In the rest of the spectrum we may still easily distinguish other four lines sufficiently bright *.

In making the light of a lamp fall through a narrow aperture, from 15″ to 30″ wide, upon a prism of great dispersion, placed before the telescope, we perceive that the red line of this spectrum is formed by two very delicate bright lines, similar in size and in distance to the two dark lines D, Fig. V. Plate VII. Whether the aperture through which the light of the lamp passes is wide or narrow, if we cover the point of the flame, and the lower blue extremity of it, the red line appears less clear, and is more difficult to be distinguished. Hence it appears that this line derives its origin principally from the light of the two extremities of the flame, particularly the inferior one.

* In order to obtain a continuous electrical light, I brought to within half an inch of each other, two conductors, and I united them by a very fine glass thread. One of the two was connected with an electrical machine, and the other communicated with the ground. In this manner, the light appeared to pass continuously along the glass fibre, which consequently formed a fine and brilliant line of light.

The reddish line is, in relation to the other parts of the spectrum, very bright in the spectra of light produced by the flame of hydrogen gas and alcohol. In the spectrum of the flame of sulphur, it is seen with difficulty.

I intend to repeat the experiments relative to the perfection of the Achromatic Telescope, with a new instrument, by which I expect to obtain a degree of accuracy more than double of that of which the preceding observations are susceptible. I shall add to them new experiments made with the same instrument, and for which the instrument already described was not adapted. These last may perhaps be of great interest in practical and physical optics.

In making the experiments of which I have spoken in this memoir, I have considered principally their relations to practical optics. My leisure did not permit me to make any others, or to extend them farther. The path which I have traced out in this memoir, may furnish interesting results in physical optics; and it is therefore greatly to be wished that skilful natural philosophers would condescend to give them some attention.

ART. VI.—*On Rock Formations.* By Baron ALEXANDER HUMBOLDT *.

THE word *formation* designates, in Geognosy, either the manner in which a rock has been produced, or an assemblage of mineral masses, which are so connected together, that they are supposed to have been formed at the same period, and present, in the most distant parts of the world, the same general relations of situation and position. It is thus that the *formation* of obsidian and basalt is attributed to subterranean fires; and thus also that we say the formation of transition clay-slate contains lydian-stone, chiastolite, alum-slate, and alternating beds of black limestone and porphyry. The first acceptation of the word is better adapted to the genius of the language; but it has relation to the origin of things, to an uncertain science founded upon geogonic hypothesis. The second acceptation, now

* Translated from *Essai Geognostique* par Alexandre de Humboldt.

generally adopted by the French mineralogists, has been borrowed from the celebrated school of Werner: it indicates what is, not what is supposed to have been.

In the geognostical description of the globe, we may distinguish different degrees of aggregation of mineral substances, simple or compound, according as we rise to more general ideas. Rocks which alternate with one another, which are usually associated, and which present the same relations of position, constitute a *formation;* the union of several formations constitutes a district or *terrain;* but these different terms of rocks, Formation and Terrain, are employed as synonymous in many works of geognosy.

The diversity of the rocks, and the relative disposition of the beds which form the oxidised crust of the earth, have, from the most remote times, fixed the attention of men. Wherever the working of a mine was directed upon a deposit of salt, of coal, ~~or of~~ clay-iron, which was covered with a great number of beds of different natures, it gave rise to ideas more or less precise regarding the system of rocks peculiar to a district of small extent. Furnished with these local details, and full of prejudices which arise from custom, the miners of a country would disperse themselves over the neighbouring districts. They would do what geognosts have often done in our days; they would judge of the position of rocks of whose nature they were ignorant, according to imperfect analogies, according to the circumscribed ideas which they had acquired in their native country. This error must have had a fatal influence upon the success of their new researches. In place of examining the connection of two contiguous districts, by following some generally extended bed,—in place of enlarging and extending, so to speak, the first *type of formations* which had remained impressed upon their minds,—they would be persuaded that each portion of the globe had an entirely different geological constitution. This very old popular opinion has been adopted and supported, in different countries, by very distinguished men; but since geognosy has been elevated to the rank of a science, the art of interrogating nature brought to perfection, and journeys made into distant countries, have presented a more exact comparison of different districts, great and immutable laws have been discovered in the structure of the globe, and in the super-

position of rocks. Since, then, the most striking analogies of situation, of composition, and of organic bodies contained in contemporaneous beds, have manifested themselves in the two worlds, in proportion as we become accustomed to consider the formations under a more general point of view, even their *identity* becomes every day more probable.

In fact, on examining the solid mass of our planet, we perceive that some of those substances with which oryctognosy (descriptive mineralogy), makes us acquainted in their individual capacities, are met with in *constant associations*, and that these associations, which are designated by the name of Compound Rocks, do not vary, like organic beings, according to the differences of the latitudes, or of the isothermal lines in which they occur. The geognosts who have travelled over the most remote countries, have not only met in the two hemispheres with the same simple substances, quartz, felspar, mica, garnet or hornblende; but they have also found that the great mountain-masses present almost everywhere the same rocks, that is to say, the same assemblages of mica, quartz and felspar in the granite; of mica, quartz, and garnets in the mica-slate; of felspar and hornblende in the syenite. If it has sometimes been thought at first that a rock belonged exclusively to a single portion of the globe, it has been constantly found by later researches, in regions the most remote from its first locality. We are tempted to admit that the formation of rocks has been independent of the diversity of climates; that perhaps it has even been anterior to them, (Humboldt, *Geographie des Plantes*, 1807, p. 115.; *Vues des Cordilleres*, vol. i. p. 122). Rocks are found to be identical where organic beings have undergone the most varied modifications.

But this identity of composition, this analogy which is observed in the association of certain simple mineral substances, might be independent of the analogy of relative situation and of superposition. One may have brought from the Islands of the Pacific Ocean, or from the Cordilleras of the Andes, the same rocks which are observed in Europe, without his being permitted to conclude that these rocks are superimposed in the same manner, and that after the discovery of one of them it might be predicted with some degree of certainty what are the other rocks

which occur in the same places. It is to discover these analogies of situation and relative position, that the labours of geognosts should tend, who delight to investigate the laws of inorganic nature. In the following tables, we have attempted to unite all that is known with certainty, regarding the superposition of rocks in the two Continents, to the north and south of the Equator. These *types of formatians* will not only be extended, but also variously modified, in proportion as the number of travellers qualified to make geognostical observations shall become increased, and as complete monographs of different districts at great distances from each other shall furnish more precise results.

The exposition of the laws observed in the superposition of rocks, forms the most solid part of the science of geognosy. It must not be denied, that the observations of geognostical situation often present great difficulties, when the point of contact of two neighbouring formations cannot be reached, or when they do not present a regular stratification, or when their relative situation is not *uniform,* that is to say, when the strata of the upper deposits are not parallel to the strata of the lower. But these difficulties (and this is one of the great advantages of observations which embrace a considerable part of our planet), diminish in number, or disappear entirely, on comparing several districts of great extent. The superposition and relative age of rocks, are facts susceptible of being established immediately, like the structure of the organs of a vegetable, like the proportions of elements in chemical analysis, or like the elevation of a mountain above the level of the sea. True geognosy makes known the outer crust of the globe, such as it exists at the present day. It is a science as capable of certainty as any of the physical descriptive sciences can be. On the other hand, all that relates to the ancient state of our planets, to those fluids which, it is said, held all the mineral substances in a state of revolution, to those seas which we have raised to the summit of the Cordilleras, to make them again disappear, is as uncertain as are the formation of the atmosphere of planets, the migrations of vegetables, and the origin of different varieties of our species. Yet the period is not very remote when geologists occupied themselves by preference with the solution of these almost impossi-

ble problems, with those fabulous times of the physical history of our planet.

In order to render the principles better understood, according to which the following *table of the superposition of rocks* is constructed, it becomes necessary to premise observations furnished by the practical examination of different districts. We shall begin with remarking, that it is not easy to circumscribe the limits of a formation. The Jura limestone and the Alpine limestone, which are separated to a great distance in one country, sometimes appear closely connected in another. What announces the independence of a formation, as has been very justly observed by M. de Buch, is its immediate superposition upon rocks of a different nature, and which consequently ought to be considered as more ancient. The red sandstone is an independent formation, because it is superimposed indifferently upon black (transition) limestone, upon mica-slate, or upon primitive granites; but in a country where the great formation of syenite and porphyry predominates, these two rocks constantly alternate. There results that the syenite rock is dependent upon the porphyry, and scarcely any where covers by itself the transition clay-slate or primitive gneiss. The independence of formations does not, besides, by any means exclude the *uniformity* or *concordance of position*; it rather excludes the oryctognostic passage of two superimposed formations. The transition districts have very often the same direction and the same inclination as the primitive ones; and yet, whatever approximation there may be between their origin, we are not the less warranted to consider the anthracitic mica-slate or the grey-wacke, alternating with porphyry, as two formations independent of the primitive granites and gneisses which they cover. The conformity of position is in no way incompatible with the independence of formations, that is to say, it does not prevent the right which one has of regarding a rock as a distinct formation. It is because the independent formations are placed indifferently on all the older rocks, (the chalk upon the granite, the red sandstone upon the primitive mica-slate), that the assemblage of a great number of observations made upon very distant points, becomes eminently useful in the determination of the *relative age* of rocks. In order to determine that the zircon-sienite is

a transition rock, it must have been seen resting upon formations posterior to the black limestone with orthoceratites. Observations made upon the porphyries and syenites of Hungary by M. Beudant, one of the most distinguished geologists of the present times, may throw much light upon the formations of the Mexican Andes. It is thus that a new vegetable discovered in India, elucidated the natural affinity between two families of plants belonging to Equinoctial America.

The order which has been followed in the table of formations, is that of the situation and relative position of rocks. I do not pretend that this position is observed in all the countries of the globe; I merely point it out such as it has appeared the most probable, after the comparison of a great number of facts which I have collected. It is by the idea of the relative age of formation, that I have been guided in this work, imperfect as it still is. I had begun it long before my journey to the Cordilleras of the New Continent, from the year 1792, when, on leaving the Freyberg School, I was appointed to the direction of the Mines in the mountains of the Fichtelgebirge. The same rock may vary in composition, integrant parts may have been abstracted, and new substances may occur disseminated, without the rock's changing its denomination in the eyes of the geognost who is engaged with the superposition of formations. Under the equator, as in the north of Europe, strata of a true transition syenite lose their hornblende, without the mass becoming another rock. The granites of the banks of the Orinoco sometimes assume hornblende as an integrant part, and yet do not cease to be primitive granite, although this may not be of the first or oldest formation. These facts have been observed by all practical geologists. The essential character of the identity of an independent formation is its relative position, the place which it occupies in the general series of formations. (See the classical Memoir of M. de Buch, *Ueber den Begriff einer*, in the *Mag. der Naturf.*, 1810, p. 128–133.) It is on this account that an isolated fragment, a specimen of rock found in a collection, cannot be determined geognostically, that is to say, it cannot be referred with certainty to a particular formation, constituting one of the numerous beds of which the crust of our planet is composed. The presence of chiastolite, the ac-

cumulation of carbon or nodules of compact limestone in the clay-slates, nigrine and epidote in the syenites, (alternating with granite and porphyries), conglomerates or pudding-stones, having a basis of anthracitic mica-slate, may, without doubt, be characteristic of transition formations; in the same way as, according to the useful labours of M. Brongniart, petrifactions of shells, in a good state of preservation, sometimes indicate directly such or such a bed of tertiary deposits. But these cases, where we are guided by disseminated substances or by characters purely geological, comprehend but a small number of rocks of a recent origin, and observations of this kind often lead only to negative facts. The characters taken from the colour, from the grain, and from small veins of carbonate of lime, which traverse calcareous rocks; those which are furnished by the fissility and silky lustre of clay-slate, the aspect and undulations more or less marked of the scales of mica in mica-slate; and, lastly, the size and colouring of the crystals of felspar in the granites of different formations, may, like all that is connected simply with the *physiognomy* of minerals, lead the most expert observer into error. The white and black tints undoubtedly in most instances distinguish the primitive and transition limestones; the Jura formation, especially in its upper beds, is also without doubt generally divided into thin whitish beds, having a dull, even, or conchoidal fracture, with very flat cavities: but in the mountains of transition limestone there are isolated masses which, in colour and texture, resemble the oryctognostic characters of the Jura limestone; and to the south of the Alps there are hills belonging to tertiary deposits, where we find rocks analogous to the slaty and dull Jura limestone (in as far as regards appearance,) in formations placed above the chalk, and which resemble the limestone used for lithographic purposes. Were names taken from their oryctognostical characters alone to be preferred in distinguishing formations, the different strata of the same compound rock having a considerable thickness, and extended to a great length in a particular direction, would often seem to belong to different rocks, according to the points at which specimens were taken. Consequently we can only determine geognostically in collections, *suites of rocks* of which the mutual superposition is known.

In announcing these ideas regarding the sense which should be attached to the words *independent formations*, when treating of the order of their position, we are very far from undervaluing the eminent services which the most rigorous oryctognostic examination, the minute investigation of the composition of rocks, have rendered to modern geognosy, and especially to the knowledge of the relative position of formations. Although, according to the discoveries of M. Haüy, regarding the intimate nature of inorganic and crystallized substances, there does not exist, properly speaking, a passage or transition of one mineral species to another; (Cordier, *sur les Roches volcan.*, p. 33., and Berzelius, *Nouv. Syst. de Mineral*, p. 119.), the passages of *masses or pastes of rocks*, are not limited to formations which are commonly distinguished by the name of Compound Rocks. Those which are thought simple, for example, the transition or secondary limestones, are partly amorphous varieties of mineral species, of which there exists a crystallized type, partly of aggregates of clay, carbon, &c., which cannot be submitted to any fixed determination. It is upon the variable proportions of these heterogeneous mixtures, that the passage of marly limestones to other schistose formations is founded. (Haüy, *Tableau comparatif de la Cristallographie*, p. 27.—30.) All the amorphous pastes of rocks, however homogeneous they appear at first sight, the bases of porphyries and euphotides (serpentines), as well as those problematical black masses which constitute the *basanite* (basalt) of the ancients, and which are not all greenstones surcharged with hornblende, are susceptible of being subjected to mechanical analysis. M. Cordier has applied this analysis in an ingenious manner to the diabases, dolerites, and other more recent volcanic productions. The most apparently minute oryctognostic examination, cannot be indifferent to the geognost who examines the age of formations. It is by this examination that we are enabled to form a just idea of the progressive manner in which, by *internal development*, that is to say, by a very gradual change in the proportions of the elements of the *mass*, the passage is made from one rock to a neighbouring. The transition slates, whose structure appears at first so different from that of the granites or porphyries, present to the attentive observer striking examples of insensible passages to granular rocks of porphyritic

or granitic nature. These slates become at first greenish and harder. In proportion as the amorphous paste receives hornblende, it passes into those hornblendic traps which in former times were confounded with basalt. In other cases, the mica, which is at first concealed in the amorphous paste, becomes developed, and separates into distinct and clearly crystallized spangles; at the same time, the felspar and quartz become visible; and the mass assumes a granular aspect, with very elongated grains: this is a true transition gneiss. By degrees, the grains lose their common direction; the crystals arrange themselves around many centres; the rock becomes a transition granite or syenite. In other cases, the quartz alone is developed; it augments, and becomes rounded into nodules, and the slate passes to the best characterized grey-wackes. By these certain signs, geognosts, to whom the appearances of nature have become familiar by long examination, become aware beforehand of the proximity of granular, granitic and arenaceous rocks. Analogous passages of primitive mica-slate to a porphyritic rock, and the return of this rock to gneiss, are observed in the eastern parts of Switzerland. (See the luminous developments given by M. de Raumer, *Fragmente*, p. 10. and 47.; M. Leopold de Buch, in his *Voyage de Glaris à Chiavenna, fait en* 1803, and inserted in the *Magaz. der Berl. Naturf.*, vol. iii. p. 115). But these passages are not always insensible and progressive; the rocks often also succeed each other quickly, and in a very abrupt manner; often (for example, at Mexico, between Guanaxuato and Ovexeras), the limits between the slates, the porphyries and syenites, are as distinct as the limits between the porphyries and limestones; but even in this case geognostical relations with the superimposed rocks are indicated by additional heterogeneous beds. It is thus that the transition granite of the syenitic formation presents beds of basanite, by becoming charged with hornblende: it is thus, also, that these same granites sometimes pass to euphotide. (Buch, *Voyages en Norwege*, vol. i. p. 138., vol. ii. p. 83.)

There results from these considerations, that the mechanical analysis of amorphous pastes, by means of demi-triturations and washings, (an analysis of which, M. Fleuriau de Bellevue made the first attempt, that was crowned with success; *Journ. de*

Physique, vol. li. p. 162.), throws light at once, 1*st*, Upon the large crystals which are isolated and separated from the microscopic crystals entangled in the *mass* ; 2*dly*, On the mutual passages of some rocks, superimposed the one upon the other ; 3*dly*, On the subordinate beds, which are of the same nature as one of the elements of the amorphous mass. All these phenomena are produced, if we may so speak, by internal development; by variation in the constituent parts of a heterogeneous mass. Crystalline molecules, invisible to the eye, occur enlarged and disengaged from the compact tissue of the paste; by their assemblage and mixture with new substances, they insensibly become intercalated beds of considerable thickness; and not unfrequently they even become new rocks.

It is the intercalated beds which especially merit the greatest attention. (Leonhard, Kopp and Gærtner, *Propæd. der Miner.*, p. 158.) When two formations succeed each other immediately, it happens that the beds of the one begin at first to alternate with the beds of the other, until (after these precursors of a great change) the newest formation shows itself without any mixture of subordinate beds. (Buch, *Geogn. Beob.* vol. i. p. 101. 156.; Humboldt, *Rel. Hist.* vol. ii. p. 140.) The progressive developments of the elements of a rock, may, consequently, have a great degree of influence upon the relative position of the mineral masses. Their effects belong to the province of geology; but, in order to discover and appreciate them, the observer must call to his assistance oryctognosy.

In exposing the intimate relations by which we often see the phenomena of *composition* connected with those of relative *situation*, it has not been my intention to speak of the purely oryctognostic method, which considers rocks according to the analogy of their composition alone. (*Journal des Mines*, vol. xxxiv. No. 199.) In the classifications of this method, abstraction is made of every idea of superposition; but they do not the less give rise to interesting observations regarding the constant assemblage of certain minerals. A purely oryctognostic classification, multiplies the names of rocks more than is required by geognosy, when occupied with superposition alone. According to the changes which the mixed rocks undergo, a stratum of great extent and thickness may contain (we must repeat it here) parts

to which the oryctognost, who classes rocks according to their composition, would give entirely different denominations. These remarks have not escaped the learned author of the *Classification Mineralogique des Roches*; they must have presented themselves to an experienced geognost, who has so successfully investigated the superposition of the deposites of which he has treated. "We must not confound," says M. Brongniart, in his late Memoir on the position of the Ophiolites, "the relative positions, the orders of superposition of the deposites and of the rocks which compose them, with purely mineralogical descriptions. The neglect of making the proper distinction in this case, would necessarily be productive of confusion in the science, and would retard its progress." The arrangement which we give at the end of this article, is by no means what is called a classification of rocks; there will not even be found united, under the title of particular sections (as in the old geognostical method of Werner, or in the excellent *Traité de Geognosie* of M. D'Aubuisson), all the primitive formations of granite, nor all the secondary formations of sandstone and limestone. It has been attempted, on the contrary, to place each rock as it occurs in nature, according to the order of its superposition or of its respective age. The different formations of granite are separated by gneisses, mica-slates, black-limestones and grey-wackes. In the transition rocks, we have separated the formations of porphyries and syenites of Mexico and Peru, which are anterior to the grey-wacke, and to the limestone with orthoceratites, from the much more recent formation of the zircon-porphyries and syenites of Scandinavia. In the secondary rocks, we have separated the oolitic sandstone of Nebra, which is posterior to the alpine limestone or zechstein, from the red-sandstone, which belongs to the same formation with the secondary porphyry and amygdaloid. According to the principle which we follow, the same names of rocks occur several times in the same table. Anthracitic mica-slate is separated, by a great number of older formations, from the mica-slate anterior to the primitive clay-slate.

Instead of a classification of granitic, schistose, calcareous and arenaceous rocks, it has been my object to present a sketch of the geognostical structure of the globe; a table in which the

superimposed rocks succeed each other, from below upwards, as in those *ideal sections* which I designed in 1804, for the benefit of the *Mexican School of Mines,* and of which many copies have been distributed since my return to Europe. *(Bosquejo de una Pasigrafia geognostica, con tablas que ensenan la estratificacion y el paiallelismo de las rocas en ambos Continentes, para el uso del Real Seminario de Mineria de Mexico.)* These Pasigraphic tables united to my own observations made in both Americas what had at that period been known with precision regarding the relative position of the primitive, intermediary and secondary rocks in the Old Continent. They presented, together with the type which might be considered as the most general, the secondary types, that is to say, the beds which I have named *parallel.* This same method has been followed in the work which I now publish. My parallel formations are geognostical *equivalents ;* they are rocks which represent each other. (See the *Traité de Geologie de M. d'Aubuisson,* vol. ii. p. 255.) In England, and on the opposite Continent, there does not exist an identity of all the formations : there exist equivalents or parallel formations. That of our coal situated between the transition masses and the red-sandstone, the position of the rock-salt which occurs on the Continent in the alpine limestone, and the position of our oolites in the Nebra sandstone and Jura limestone, may guide the geognost in the approximation of remote formations. In England, we observe the coals placed upon transition formations ; for example, upon the mountain-limestone of Derbyshire and of South Wales, and upon the transition sandstone, or old red-sandstone of Herefordshire. I have thought that I recognised in the magnesian-limestone the red marl, the lias and white oolites of Bath, the *united formations* of the alpine limestone, of the oolitic sandstone and Jura limestone. In comparing the formations of countries more or less distant from each other, those of England and of France, for instance, of Mexico and Hungary, of the secondary basin of Santa Fe de Bogota and of Thuringia, we must not think of opposing to each individual rock a *parallel* one ; it must be recollected, that a single formation may *represent* several others. It is according to this principle that beds of clay, lying beneath the chalk, may, in France,

be separated in the most distinct manner from the oolitic limestone beds; while in Switzerland, in Germany, and in South America, they have for *equivalents* beds of marls subordinate to the Jura limestone The gypsums, which, in the district, are sometimes only intercalated beds in the alpine limestone or oolitic sandstone, in another district, assume all the appearance of independent formations, and occur interposed between the alpine limestone and the oolitic sandstone, between this sandstone and the muschelkalk. The learned Oxford Professor, Mr Buckland, whose extensive researches have been equally useful to the geognosts of England and of the Continent, has lately published a table of parallel formations, or, as he calls them, *equivalents of rocks*, which only extends from the 44th to the 54th degree of north latitude, but which merits the greatest attention. (*On the Structure of the Alps, and their relation with the rocks of England*, 1821.)

As in the history of ancient nations, it is easier to verify the series of events in each country, than to determine their mutual coincidence; so also more accuracy can be attained in estimating the superposition of formations in isolated regions, than in determining the relative age or parallelism of formations which belong to different systems of rocks. Even in countries which are not widely separated, in France, in Switzerland, and in Germany, it is not easy to fix the relative antiquity of the muschelkalk, of the molasse of Argovie, and of the quadersandstein of the Hartz; because rocks of general occurrence are here most commonly wanting, which, according to the happy expression of of M. de Grüner, serve as a *geognostical horizon*, and with which we might compare the three formations in question. When rocks are not in immediate contact, we can only judge of their parallelism by the relations of age existing between them and other formations by which they are united.

These inquiries of *comparative geognosy*, will long occupy the sagacity of observers; and it is not surprising that those who set out with the idea of retracing each formation in all the individuality of its relative position, interior structure and subordinate beds, should finish with utterly denying all analogy of superposition. I had the advantage of visiting, previous to my journey to the Equator, a great part of Germany, of France, of

Switzerland, of England, of Italy, of Poland, and of Spain. During these excursions, my attention was particularly directed to the relative position of formations, a phenomenon which I calculated upon discussing in a special work. On my arrival in South America, and while at first traversing in different directions the vast deposites which stretch from the maritime chain of Venezuela to the basin of the Amazon, I was singularly struck with the conformity of position which the two Continents present. (See my first sketch of a Geological Table of Equinoctial America, in the *Journal de Phys.*, vol. liii. p. 38.) Subsequent observations, which included the Cordilleras of Mexico, of New Grenada, of Quito, and of Peru, from the 21st degree of north latitude to the 12th degree of south latitude, have confirmed these first perceptions. But in speaking of analogies which are observed in the relative position of rocks, and of the uniformity of those laws which reveal to us the order of Nature, I might adduce a testimony otherwise of more weight than mine, that of the great geognost whose works have thrown the greatest light upon the structure of our globe. M. Leopold de Buch has pushed his researches from the Archipelago of the Canary Isles to beyond the Polar Circle to the 71st degree of latitude. He has discovered new formations situated between others already known; and, in the primitive as in the transition deposites, in the secondary as well as in the volcanic, he has been struck with the great features by which the table of formations is characterized in the most distant regions.

(*To be continued.*)

ART. VII.—*Description of a simple, cheap, and accurate Method of experimenting on small quantities of Gases, by means of Bent Tubes.* By Mr WILLIAM KERR.

THE greatest obstacles to experimental research that have hitherto presented themselves to young chemists, and even to proficients in the science, are the expence of the requisite apparatus, and the want of room to contain them. This has especially been the case with respect to apparatus for experimenting on

gases. These obstacles, it is hoped, the following contrivance will do much to remove.

A glass tube from 6 to 12 inches in length, and from 2 to 5 lines wide, so as to be capable of holding from 2 to 6 drachms, is to be hermetically shut at one end, and bended a little below its middle, so as to form two branches, of which the shut branch will be somewhat shorter than the other, diverging from each other nearly at a right angle. The vertex of the tube should be widened on the concave side, and this done more toward the shut than the open branch, as is represented in Plate II. Fig. 3. The vertex A of the convex side of the curvature does not correspond with B, that of the concave side, but is beneath the shut branch.

The gas evolved from the mutual action of two bodies, of which at least one is a liquid, may be collected in the shut branch in the following manner. Let the tube be held in the hand by the open end, so that this be the highest, and the shut end the lowest part of the tube; then the liquid is to be poured in till it begins to ascend above the vertex. The shut extremity is now to be elevated as high as the open end, while the vertex is depressed, so as to be the lowest part of the tube. In this position the shut branch will remain full, the liquid within it being supported by the pressure of the atmosphere on the small portion of the fluid, that is above the vertex, in the open branch. If a solid body, of greater specific gravity than the liquid, be now introduced into the open end of the tube, it will fall down to the vertex, and any gas evolved from its surface will rise through the liquid, and be collected in the shut branch, while the liquid will ascend in that which is open. Owing to the vertex of the convex side being beneath the shut branch, while that of the concave is nearer the open one, the whole, or almost the whole of the gas evolved, from any bit of solid matter resting on the most depending part of the curvature, will ascend into the shut branch. In this manner the gas is collected unmixed with common air, and if the experiment requires the application of heat, the bent tube may be placed in a sand-bath; so that by means of such tubes, experiments may be performed on small quantities of gases, not only more economically, but, it is hoped, more accurately than is commonly done on larger quantities, with a more costly apparatus.

A bent tube of the form described, may be also used for discovering the quantity of gas absorbed by a liquid. For example, the quantity of oxygen absorbed from atmospheric air by a solution of the protosulphate of iron. The air being confined in the sealed branch, by the solution contained in the open one, will be exposed to the pressure of the column of liquid, and as the open end may be corked, the solution can absorb no other gas but that contained in the tube. The quantity absorbed may be known by tying, at the commencement of the experiment, a waxed thread around the tube, at the boundary of the air and liquid.

Other gases may be absorbed by other liquids, in nearly the same manner; for instance, carbonic acid by milk of lime; only when any other gas than atmospheric air is introduced into the tube, the whole tube must be previously filled with water. The water in the open branch, with the exception of a small quantity sufficient to confine the gas, is then to be sucked out with a straw or small glass tube, and the milk of lime substituted for it.

A bent tube of a small size answers best for collecting gas; and one of a larger size for the absorption of gases.

If the experiment to be performed requires any considerable time, the curvature of the tube may be passed through a slit made in a thin board, the slit being of such length that the branches of the tube may rest upon the board at the extremities of the slit. Experiments may be going on, at the same time, in several tubes, placed in as many slits in the same board, which may be made to form part of a very convenient portable frame, for holding a number both of bent tubes for gases, and test tubes for precipitations.

Fig. 4. is the plan of a board, which may be made of mahogony, 8 inches square, and $\frac{1}{4}$ of an inch thick. In it there are eight slits for bent tubes, and at one end it is pierced with eight holes for test tubes. This board forms the top of the frame. Another board of the same dimensions, parallel to the former, forms the sole; and these two boards are connected together, at the corners, by four small wooden pillars. The whole frame need not weigh more than eleven ounces. It may be placed on a table or shelf, and may be lifted from one place to another, loaded with all the tubes that it is intended to contain, without disturbing any of the processes going on in these.

The slits and holes should be numbered, and a register kept of the processes going on in each of the tubes, by which they are occupied.

It is hoped that bent tubes will be found useful to students at Universities, to travellers, and to those who cannot carry large, brittle, and expensive apparatus along with them.

To those who have not the means of purchasing expensive chemical apparatus, the bent tubes will recommend themselves by their cheapness, each of them superseding, for small experiments, a retort, a pneumatic trough, and a receiver.

In the laboratory of the chemist they will also be useful, by enabling him to perform experiments, in the small space of 8 or 9 inches square, which would have otherwise required 8 or 9 retorts, and as many receivers.

An addition may be made to these tubes, by which the quality of the gas evolved at any period of the experiment may be examined, without disturbing the process going on. An account of this improvement will be the subject of an early communication.

Paisley,
October 1823.

Art. VIII.—*Account of the Earthquake which happened in Chili, on the* 19*th of November* 1822 *.

I cannot refuse myself the pleasure of writing to you by so good an opportunity as that which now offers itself, particularly as I heard that you wished to have an authentic account of the earthquake which has taken place at Chili. I have received my information from some very intelligent persons; but as they all seem to agree, I shall adhere more particularly to that given by a friend of mine, who has taken notes. The whole description would fill a volume; so that I shall select those observations from memory, which I think are unlikely to have been inserted in the public prints, and which I think will be most interesting to you.

On the night of the 19th November 1822, at Quintera, the usual sea-breeze had completely subsided about 8 o'clock P. M.;

* Extracted from a letter which we have been favoured with a sight of.

the atmosphere was perfectly clear, and it was a lovely moonlight; no change was observed in the temperature. At $9^h\ 30^m$ the first shock was felt, and the precise moment is curiously ascertained, by all Roskil's chronometers having stopped precisely at the same time *. And by all accounts, which, of course, are vague, owing to the inaccuracy with which time is generally kept in that part of the world, the earthquake was felt at the same moment throughout Chili. During that night there were about seven principal shocks, and continual inferior ones; so that Mrs Graham (the author,) it is said, held her watch in her hand 45 minutes, with a glass of water on the ground near her, and the water was shaken as nearly as possible every 5 minutes. The earthquake was felt at Conception slightly, more severely at Copiapo and Coquimbo, and some say at Lima, but this I think very doubtful. Valparaiso, Quillota, and Casa Blanca, seem to have been the centre (if I may express it so); and when my friend left it, which was three weeks after the first shock, it was still continuing at intervals, I suppose about three times a-day. At Valparaiso the ravages are inconceivable, and upwards of 300 bodies have already been dug out, mostly children and soldiers, which, I believe, taking the difference of population into account, exceeds any thing yet heard of, even at the great earthquake in Syria. I forgot to mention that it was felt at Mendosa, a town on the eastern side of the Andes, in the line of Buenos Ayres, and for some little way on each side of that town; and every endeavour was made to discover if it had taken place at Juan Fernandez, but this has proved quite unsuccessful, there being no inhabitants on that island.

The water retired with great rapidity in the outset, so as to leave the launches dry opposite the Custom House; but the return was gradual, much to the satisfaction of the inhabitants, and against the prophecies of the priests, who expected to have been swallowed up by it. Mrs Graham, and all other authorities, seem to agree particularly on this head, that the whole line of coast has either risen, or the water has subsided nearly two

* This I conceive to be a mistake, as I have seen a memorandum attached to a chronometer, in the handwriting of that watchmaker, in these words, "Let down at the earthquake." Besides which, I should at once say the cause was inadequate to stop a number of watches at once.

feet, and that rocks have made their appearance above water, which before were never seen, even at the lowest tides.

The motion and direction of the shock was from NW. to S.E.; and fissures running parallel to one another in a NW. and S.E. direction, from a few inches to two or three feet wide, were discovered after the earthquake, throughout the whole district, wherever it was felt. At Vina de la Mar, which, you recollect, a few miles from Valparaiso, cones from two to six feet high were thrown up of sea sand, of which the little valley is composed. No smell, gaseous exhalations, nor steam, have been taken notice of; we may therefore suppose that none existed at the time. The houses situated on the loose alluvial soil, and in the Almendral, a sort of suburb adjoining Valparaiso, were generally shaken down, while those built on the rock mostly weathered the shock. Mr George Coode's new house on the beach, which he took so much pains to found upon the rock, is a good deal rent, but not so much as those on the opposite side of the street, and Mr Hoseason's house is completely demolished. Every church in the place, also the Fort, and Government-house, are totally ruined. At Santiago, the capital, the damage is inconsiderable, a few houses having suffered in the roofs. Quillota is reported to be completely in ruins: it stands on alluvial soil in the valley near the river of that name, and on a dead flat about seven leagues from the sea.

It is to be observed, that water placed in a tumbler on the ground during the principal shocks, which were undulatory, was not tremulously agitated, but, as it were, thrown up on the side of the glass like a wave. On the contrary, during the inferior shocks which are described as vibrating perpendicular to the general direction of the great convulsion, the water in the tumbler was observed to have a bubbling motion. The average duration of the shocks was about 30 seconds. Mercury was also made use of, and the same phenomena noticed.

As felt on board the ships in the bay, it is described as if the chain-cable had run out in an instant; but we have very unsatisfactory accounts of the general effects on the ocean. Sounds like distant artillery were heard some days after the commencement of the earthquake, but were not taken notice of at the time.

RIO DE JANEIRO,
August 4. 1822.

Art. IX.—*Account of two Maps of Zænmæ or Yangoma.* By Francis Hamilton, M. D. & F. R. S. & F. A. S. Lond. & Edin.—With a Plate. Communicated by the Author.

In the English translation of M. Malte Brun's System of Geography (vol. iii. p. 363.), this compiler is made to say, "We are totally unable to fix the locality of the kingdom of Yangoma. D'Anville's map places Yangoma near the sources of the western branch of the Meinam, or river of Siam. In other modern maps, it is left out as too uncertain to be admitted." Certainly, if we imagine Yangoma to be such a country as M. Malte Brun describes it, we shall no where find such to exist; but, as I have already mentioned (Philosophical Journal, vol. ii. p. 268.), there can be no doubt, that the Jangomas of the Universal History (London, 8vo. 1759, vol. vii. p. 135, 137.) are the same people with the Jun or Yun Shan of the Mranmas, and that their capital is the Zænmæ of the Mranmas, or Chiamay of Loubere, which, in Mr Arrowsmith's map of Asia, is called Zemee.

Soon after I had received the general map, of which I have given an account in the 2d volume of this Journal (p. 89, 262.), the same person who composed it gave me the first of the accompanying maps (See Plate III.); and as this contained no distances, he, at my request, made out the second map, in which these are given; and the manner of delineating the country is altered. In the first map, the river Saluæn, forming the western boundary, is represented by a line drawn straight by a rule; and the other rivers are made of an enormous width. In the second map, the manner of delineation is more accordant to European ideas. In the first map, the hills are represented in a kind of rude perspective, when, of course, they appear as ridges; but, in the second, the spaces occupied by mountains are surrounded by a line, as lakes are denoted in our maps. I am not sure but that this is a more accurate method than what has been adopted by many more scientific geographers; and, if it had been followed, many of what are called chains and ridges of mountains, would disappear from our maps; for I suspect, that such have sometimes originated from early attempts to delineate them in a kind of perspective, as in the first map of the slave. Thus, imaginary

ridges were produced in our maps, and obtained a name which has been continued in subsequent delineations, and Nature forced to comply with the imaginations of imperfect science. Such, for instance, is the Chain of the Grampian mountains, among which I now write, and which exists merely in the imagination of geographers, the whole of Scotland being a cluster of hills; among which narrow valleys wind in all directions.

Although, in some respects, the second of the accompanying maps is the most perfect, yet I have judged it expedient to publish both, for the following reasons.

As the first map was in my possession while the second was drawing, a comparison between the two will enable us to judge what reliance can be placed on the slave's accuracy of memory. On the whole there is a wonderful correspondence between the two maps; but yet there are essential differences, which must put us on our guard in placing an implicit reliance on his accuracy. Thus, in the first map, M. Tin is placed above the junction of the Anan, with the river of Siam; while, in the second map, it is placed below. In the first map, we have M. Sæn as a town on the Anan; which, in the second map, is named M. Gan. This, perhaps, was owing to my mistake in copying; or, perhaps, to an error in the slave's reading, the initials of the two words in the Mranma character being much alike. In the first map, a small river, falling into the Mækhaun, is called Main Go Khiaun, because it rises near a town named M. Go; but, in the second map, it is called M. Zæn, because it passes near a town named M. Zæn. Again, in the first map Lanuæh, towards upper Laos, is placed on the west side of the Mæle; while, in the second map, it is on the east; south from thence, in the second map, we have M. Bhæ in place of M. Læ of the first, the characters being very nearly alike. M. Læ is the proper name, as I found it thus written in the original characters in the first map; while, in the second, the original character had been obliterated. In the second map, Tamat occupies the place which Mrr̃so does in the first, and the latter place is altogether omitted; but, in the second map, we have in the same vicinity M. Kiin, a town not mentioned in the first. There are thus two towns in both maps; but in each, one of these towns is named in a different manner, and the situation of the other differs, Khiaun Tamat

being placed west from the Main Zin river in the first map, and east from the same in the second. Finally, in the second map, Maikkhia is placed nearer *Zænmæ* than Naghain; while, in the first map, the reverse is the case. These differences are thus not numerous, and some of them bear an explanation, without supposing any great error in the construction.

The most essential reason, however, for publishing both maps is, that the second contains only the places near the capital; because it was of these only that the compiler recollected the respective distances. The whole towns, therefore, that are mentioned in the first map, towards the Saluæn river, towards the frontiers of Siam and Kiainroungri, and on the east side of the Mækhaun, are omitted in the second, except M. Gain; which, as being a place of very great importance, and its distance well known, is mentioned in both.

Although, in the second map, the compiler has mentioned the distances between the respective places, he has made no attempt to lay them down by a scale. Thus, for instance Sinhoun, which is only six leagues from Zænmæ, is placed farther from this city than from Anan, which is three days' journey distant; and, on the whole, I am inclined to think, that the relative situations of the places are best represented in the first map. The essential place at the Saluæn, where the lines, denoting distances, commence five days' journey from Pabaun, and which is not named in these maps, I know to be Dhanukia Zeip, said to be three days' journey east from Monæh, one of the Shanwa towns, which is nearly at an equal distance from Amarapura and Taunu, but considerably to the east of the direct line between these two cities.

I now proceed to compare these draughts with the general map, of which an account was given in the second volume of this Journal. By this means, we shall be able to form some judgment concerning the extent which the Jun Shan occupied in 1795, when the map was drawn.

In the general map, as well as in both the particular ones, the western boundary of the Jun Shan is the river Saluæn. We are told by M. Malte Brun, (English translation, t. iii. p. 332.), that M. d'Anville considers the rivers of Martaban and Pegu as two mouths of one great river; that modern English travellers tell us,

that the river of Pegu is small, and rises but a short way from the sea; from which he concludes, that these travellers undoubtedly mean some small stream which falls into the Pegu river of d'Anville. Farther, we are informed, that M. d'Anville, in assigning the course of the Nookian (Loukiang), which comes from Thibet through China, to the river of Pegu, and I, in giving that course to the Saluæn (Thaluæn), or river of Martaban, have told precisely the same thing. No person has a greater respect for the authority of M. d'Anville than the author. I look upon him as the greatest of geographers, and am happy to shelter myself under his authority, in bringing the Nookian of Thibet to the sea at Martaban; and it is to be regretted, that M. Malte Brun should have ventured on departing altogether from M. d'Anville's opinion, and have carried the Nookian to Siam (l. i. p. 333). If this compiler had taken the pains to read the account of C. Symes, he would have seen, that, from Rangoun, on a branch of the river of Ava, the British Embassy proceeded up the river of Pegu to that city, and that, therefore, the river of Pegu falls into the river of Ava, while a very large river, the Zittaun or Paunlaun, is interposed between it and the Saluæn at Martaban. Even if the river, passing Pegu, had fallen into the Saluæn, it would have been a strange kind of nomenclature to have called the latter the river of Pegu. What would M. Malte Brun think of an Englishman, who chose to call the Loire the river of Poictiers, because this city stands on one of its small branches? To be sure, the calling the Saluæn the river of Pegu is still more extraordinary, and could only be equalled by any one who should choose to call the Loire the river of Paris, because the river passes through the dominions of a Prince who resides in that city. M. d'Anville would never have imagined such a nomenclature, and was led into the mistake by supposing, from the imperfect materials in his possession, that the Nookian divided into two branches; on one of which stood Pegu, and on the other Martaban. But this is entirely contradicted by every information that I received in Ava. It must be farther observed, that this error, respecting the river of Pegu, did not originate with M. d'Anville, but was that then commonly received; especially by the very learned compilers of the Universal History, as I have mentioned in this Journal, (vol. v. p. 80).

In Mr Arrowsmith's map of Asia, the Saluæn, I suspect, is placed too far to the west, leaving thus too little room for the Shanwas, and enlarging too much the territory of the Jun Shan. There is reason to think, as I have mentioned (vol. v. p. 82), that Maitäl an has been placed by Mr Arrowsmith too far to the west, and I see no authority for giving the Saluæn the great bend to the west, between the 22d and 23d degrees of latitude. On the contrary, all the authorities which I received made it run, without any considerable bend, until it approached the sea, where it turns towards the west for 30 or 40 miles, before it enters the Gulph of Martaban. We may, therefore, I am persuaded, place the course of this river downwards, from between the 22d and 23d degrees of latitude, half a degree farther east than Mr Arrowsmith has done; and thus the Saluæn, in Lat. 20° N., near the centre of the Jun Shan territory, should be in Long. 98° 27′ E. from Greenwich, in place of 97° 57′, where it is placed in Mr Arrowsmith's map.

It is not only, however, the Saluæn that must be carried farther east, than Mr Arrowsmith has done; but Zænmæ must be moved at least as far in the same direction; and, of course, it must be followed by that part of the river of Siam on which it stands, thus giving the lower part a direction nearly north and south. I have already mentioned the surmises of M. Malte Brun concerning the identity of this river with the Nookian of Thibet, or Loukiang of China; but, as these surmises rest merely on the size of the river of Siam in the lower part of its course, they have no weight; for, below Zænmæ, it receives by the Anan a considerable proportion of the waters of the Mækhaun, one of the largest rivers of Asia. The identity of the Loukiang and Saluæn, in my opinion, is fully demonstrated by the journey of the Bhanmo prince (see this Journal, vol. iii. p. 35), and by the general map of the slave (vol. ii. of this Journal). The source of the river of Siam is, I think, ascertained to be situate on the southern boundary of the Chinese province of Yunnan, where a large portion of country, between the Loukiang or Saluæn, and the Kioulong Kiang or Mækhaun, is occupied by what are called wild Lawas or Lolos, extending probably from about the 22d to the 24th degree of latitude, with a breadth, along the Tropic, of two degrees of longitude; but, measuring along the

frontier of China, upwards of 200 British miles. In this space, M. D'Anville, in his Chinese Atlas, lays down the sources of two rivers proceeding south into the territories of the Shan. The eastern of these I agree with Mr Dalrymple in considering as the Mækhoup river of the accompanying maps, which, in several authorities, is called Menantay (see this Journal, vol. ii. p. 269, 270); of course, it is a branch of the Mækhaun. The western of M. D'Anville's rivers I consider as a source of the river of Siam. Now, in the general map of the slave, this is said to rise with two heads, the Mæghuæ and the Mæpræn, the latter of which, after the junction, retains the name. But the river laid down by M. D'Anville is so near the Loukiang or Saluæn, being only about forty geographical miles distant, that it is in all probability the Mæguæ. The Mæpræn, although reckoned the chief river by the Mrammas, must therefore either have escaped the notice of the Missionaries who surveyed the province of Yunnan, or its source must be without the limits which they chose to assign to the Chinese empire. There is, however, plenty of room for a considerable river being interposed between the two laid down by M. D'Anville; as, where they leave China, they are about 120 geographical miles distant. The intervening country, being occupied by rude independent tribes, may very likely have prevented the Missionaries from reaching this branch of the river; for, if it rose on the frontier, its course, in a direct line to Zænmæ, would only be about 180 geographical miles, while the course of the western branch would be 240 miles. It is not, however, always that the longest branch of a river gives the name; for instance, the Mississipi has not run half so far as the Missouri, when the latter, on joining it, is considered as lost. The Mæghuæ probably joins the Mæpræn in about 20° 40′ N., and about half way between the junction and Zænmæ, the Mæpræn, which is a great river (Mrit) receives from the west the Mæle, which, although of considerable length, is only dignified with the appellation Khiaun, and would appear to have its source near the boundary of Upper Laos, unless we suppose it to be the same with the Mrehlo, which runs through the western parts of that country.

As I make the Mæpræn approach nearer the Mækhaun than Mr Arrowsmith does, it is necessary for me to consider, that the

small rivers rising between these great channels should have a more oblique course than has been given in the map of Asia (Arrowsmith's), which copies too nearly the rude materials furnished by the slave. The course of the Anan also, for the same reason, must be half a degree shorter than in this map. I am also of opinion, that the Main Zin, which in the map of Asia is made to come from the frontier of Upper Laos, has a much shorter course. Both maps of the slave place its source in a mountain between Tamat and Paboun, about half way between Zænmæ and that frontier.

The most essential difference between these maps, and the general one compiled by the same person, is, that, in the former, M. Gain, a military station of importance, is placed on the east side of the Mækhaun, while, in the general map, both it and Kiain Sin, another great military station, is placed between the Mækhaun and Mækhoup. I am inclined to think, that the first assigned situation for M. Gain is most likely to be true, not only because two out of three authorities are in its favour, but because the general map, being on a very small scale, the compiler probably bestowed less pains on the detail. As, in 1795, the country between the Mækhoup and Mækhaun was certainly under the government of the chief residing at Kiainsin (Kyanseng of the Universal History; see this Journal, vol. ii. p. 270), and together with M. Lach, M. Koup, and M. Sæn, on the frontier of China, formed at one time part of Upper Laos; so it is probable, that M. Gain, and the towns on the east side of the Mækhaun, formed the province of Kemarat of the Universal History. This also, in 1795, was governed by its own great military officer; but at times has also been, no doubt, subject to Upper Laos. It extends from the frontier of China in about Lat. 22° to about Lat. 20°, and is probably thirty geographical miles wide. In these maps, therefore, the Slave has not only included the country of the Jun Shan, but a great proportion of Upper Laos, that, in 1795, had been indeed separated from the prince of that country; but had not been given, entirely at least, to the prince of Zænmæ; for it is not unlikely that the towns laid down in the northern parts of the first map, but which are not mentioned in the second, may have at one time

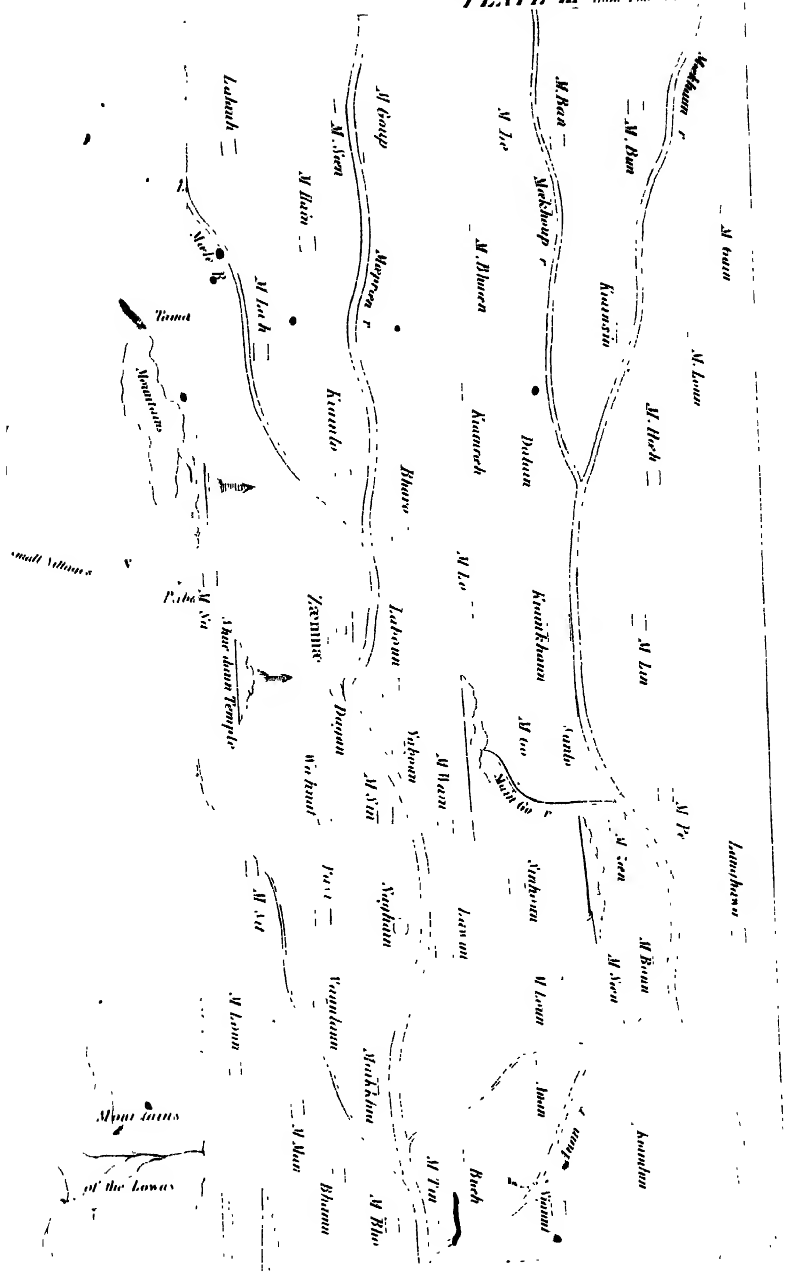
belonged to Upper Laos; at any rate, they would not appear to be under the government of the two military chiefs.

The whole territory included in the first map extends, along the parallel of 100° E. from Greenwich, from the boundary of Siam to that of China, about 200 geographical miles; and along the 20th degree of N. latitude about 200 geographical miles; and, being nearly of a quadrangular form, it will contain at least 46,000 square British miles, after making every allowance for its diminishing in length somewhat both on the S·Luæn and Mækhaun. If we allow 16,000 miles of this extent to have belonged to Upper Laos, we shall still have an extent for the principality of the Jun Shan greater than that of Scotland. Its prince, it was acknowledged, was merely tributary to the king of Ava, and among his own subjects was called a King (Pua), although the pride of the Amarapura courtiers only honoured him with the title of Zabua; but he was not called upon to attend that insolent court, when the ordinary tributaries of the Shan race (Zabuas) made their annual homage in presence of the English embassy.

The capital city, called Zænmæ by the Mranmas, in the vulgar dialect of the Siamese is called Zimæ; but its natives more commonly call it Sunabuni (built of gold), as the Mranmas usually call their capital by the magnificent title Shue Prido (golden abode of royalty). In the sacred language of these nations the name of this city is Harimunza, just as Amarapura is the sacred name of New Ava (Ænwazit). So far as I can conjecture, after weighing all accounts, it is situate in a few minutes more than 20° of N. latitude, and in a few minutes less than 100° of longitude East from Greenwich, in a situation very advantageous both for fertility and commerce, the Mæpræn being navigable to the sea, and having through the Anan a navigable communication with the great river Mækhaun. The dialect spoken by the natives of this country, which I saw at Ava, could not be distinguished by me from that of the Siammese, every word that I asked appearing exactly the same; but the accent appeared very different to the natives, although of this I was not sensible. Both nations seem also to be nearly in a similar state of society, and progress of arts.

MAP OF ZENME

PLATE III Edin. Phil. Jour. Vol. …



The distances, denoted by Roman numerals in the second map, are days' journeys; those denoted by cyphers are leagues from Ava. Both in the maps and account I have used the contraction M. for *Main* or *Hmain*, the Siammese name for *a city*.

ART. X.—*Observations on M. Beudant's Opinions regarding the Crystalline Rocks of the Red Sandstone Formation, as expressed in the 3d volume of his "Voyage en Hongrie," from* p. 194, *to* p. 206. By AIME' BOUE', M. D. Member of the Wernerian Society, &c.

IT is a well known axiom, that nothing contributes more to the advancement of science than controversy; and, for this reason, I have thought it proper to offer you some reflections upon M. Beudant's ideas regarding the origin of the crystalline deposits which are included in the oldest secondary formations. These observations will appear to you the more necessary, that they are written with the view of contradicting the opinions of a geologist, who seems anxious to evince great theoretical impartiality, and who, on this account, inspires a great degree of confidence in the minds of his readers. Besides, were I to pass over his remarks in silence, it might seem as if I began to feel that my opinions were no longer tenable; whereas, in fact, I am every day receiving additional proofs of their accuracy.

This theoretical controversy is by no means unconnected with the progress of true geological knowledge, as is the case with too many others, for the adoption of Neptunian or volcanic ideas necessarily leads to different geognostical results: with the former the geologist cannot acquire a true idea of the singular position of the crystalline secondary deposits; he is exposed to numerous errors; he is astonished to find crystallised masses amongst arenaceous ones, and at last is obliged to suppose mechanical deposits alternating with chemical ones, of which our present degree of chemical knowledge does not shew us the physical possibility.

Before opposing my arguments to those of M. Beudant, and before proceeding to demonstrate that the origin of the crystal-

line rocks of the red and coal sandstones are not so *clearly a Neptunian product* as this philosopher supposes, (*Voyage en Hongrie*, p. 195.), I must recall to mind that the opinion of the igneous origin of these rocks is founded upon their *mineralogical composition and structure*, upon their *imbedded minerals*, and upon their *geognostical position*, as I have shewn at full in my *Essai sur l'Ecosse*, p. 431. It would certainly seem that proofs, supported by observations made upon these three points by geologists of repute, might be sufficient to induce M. Beudant, as well as others, to adopt a different opinion, especially when we find that he admits, with few restrictions, the veracity of these observations; and it would seem that this being the case, the opinions advanced by the volcanists have a right to be considered as something more than "mere conjectures, derived simply from the comparison of rocks, without giving themselves the trouble of discussing the facts, or without attending to the geognostical position." (See *Travels in Hungary*, vol. iii. p. 195, line 16) This remark, which has probably escaped without due reflection on the part of its author, who on other occasions manifests a becoming degree of caution, is the more surprising, that among the proofs which he enumerates, with perfect impartiality as he professes to believe, as tending to establish the igneous origin of the trap and porphyry rocks, there is not a *single one* deduced from the geological relations of these problematic masses.

Far be it from me to reproach this candid inquirer with partiality; yet I cannot help observing, that perhaps he has not himself seen enough of similar formations, or that he does not think he can repose entire confidence in the detailed observations which many geologists have related, of the anomalous position, and various appearances, seen in the neighbourhood of the rocks in question. In the enumeration of the proofs of the igneous origin of secondary porphyry and trap rocks, he begins with shewing the perfect identity of the secondary pitchstones with those of the trachytic countries, and follows out this similarity through nearly all its details of composition, (p. 196); but afterwards (p. 199) he tells us, among the pretended Neptunian proofs which he adduces, that this analogy of the pitchstone rocks of two different epochs, is not so complete, "when these rocks are compared under more general relations." (P. 199, line 10.)

"Every where in the trachytic deposits," says this learned author, "the perlites are accompanied with porous and slaggy rocks of different varieties. Now, it is very remarkable, that there exists no trace of these in all the deposits of pitchstone with which we are acquainted. This constant absence of products, which are precisely those from which the hypothesis of an igneous origin might derive the greatest weight, is one of the strongest arguments in favour of the Neptunian hypothesis. On the other hand, when lithoid varieties have a pretty marked analogy with the lithoid perlites, if we consider with attention the relations of the several varieties through which these rocks pass, we cannot help agreeing that a perfect identity does not occur. We do not find in the pitchstone that immense quantity of small vitreo-lithoid globules, which are seen at every step in the rocks which are considered as analogous to them; nor do we observe these lithoid pitchstones modifying themselves successively, until they assume a cellular structure, with irregular cavities, as we see every where in the perlites."

It cannot certainly be said, that the pitchstones of the red sandstone formation are associated with pumice or with great scoriaceous masses, at least in the localities yet known; still the absence of these circumstances is not absolute. The pitchstones are here and there porous, at Rue Varcy in Arran, for example; at Corygills (see my *Essai sur l'Ecosse*, p. 307), and even in some points of the Saxon Trebischthal, they are even sometimes modified so much as to assume that particular cellular structure, (*à cellules dechiquetées*) as is the case in the lower part of the pitchstone of the Corygills (*Essai*, p. 315); and at Planitz the pitchstones are associated with a small set of very porous rocks. Besides, the lithoid pitchstones with small vitreo-lithoid globules are to be observed at Corygills, and are identical with those of the pearlstone, while similar varieties occur also in the Valley of Trebischthal.

It is true that all these circumstances are of much less frequent occurrence in the secondary than in the trachytic pitchstones; but it appears to me that their occurrence in both is enough to prevent our considering this rarity in the secondary rocks as one of the strongest proofs in favour of the Neptunian idea; for were we to adopt this mode of proceeding, we might

have an equal right to doubt the mechanical origin of clay-slate, grey-wacke, and even of some red sandstones, because we but seldom see their analogous rocks formed in the modern alluvium. The same reasoning might also be extended to the limestones of various epochs; and, in this case, we instantly perceive the erroneous nature of the conclusions to which this mode of proceeding would lead us.

Besides, why should we not employ, in the explanation of the differences of igneous deposits of very different ages, the same causes with which the Neptunists explain so well the variation of the aggregated products of very different epochs? Why should not the difference in age be taken into account in the first as well as in the last case, and be considered as capable of accounting for igneous as for Neptunian anomalies? Is it inconsistent with reason to suppose the laws of Nature as constant in their operations upon the terrestrial globe as in the heavens; or is it more conformable with reason to adopt this immutability for a certain class of phenomena, namely for the aqueous, mechanical, and chemical deposits; and to believe that, at a determined period, the volcanic formations have begun all of a sudden, and continued till now, while previous to that period nothing similar existed upon our planet, as none of the agents of these tremendous eruptions had been yet created? I cannot believe that a Neptunist could have conceived an idea so contrary to all natural analogy; and how absurd would not he find the person, who should contend that the alluvial deposits have begun only since the appearance of Adam and Eve on the surface of the earth? I am more inclined to suppose that my antagonists have not sufficiently considered this important question, that they have even neglected it, or vaguely resolved it, by imagining that perhaps the volcanic agents produced in those remote times, produced effects very different from those which they now produce. If this be the case, I shall readily agree with those who entertain such an opinion, for all that will then be necessary, is to determine what is meant by the terms *volcanic agents*, *volcanoes*, *igneous apertures*, *volcanic* and *igneous products*.

I would rather believe, that, after some reflection, both parties will agree in seeing the globe regulated, from the period of its

creation, by constant laws, which have, in this particular case, produced at all times aqueous and igneous deposits, although the former are at present the most generally diffused, and the others much more limited. The same must also have happened at the period of formation of the red sandstone and grey-wacke; and in fact it did so, for the igneous rocks were then nearly of as local a nature as at present. But the old Neptunian rocks present some differences when compared with those in modern times, and the same may also happen with regard to the igneous rocks of different ages. Besides, as the aqueous rocks present differences between different localities, so, in like manner, the igneous rocks of all ages are not always identical in all the localities of the same epoch; thus, for example, the Mont d'Or and Cantal group is not identical in every particular with the group of Schemnitz or Tokay, although these two deposits are in all probability nearly of the same epoch. This being admitted, when we compare the pitchstones of the old red sandstones with those of the Cantal, instead of comparing them with those of the Hungarian group, we will perceive, that, excepting with regard to the crystals of quartz, the mineralogical resemblance is still greater, for there we have no masses of pearlstone to embarrass us. Yet these pearlstones exist under the lithoid form in some localities of the ancient vitreous secondary rocks; and although they are only found in small quantities, can this form a reason for not comparing these matters to the great deposites of trachytic pearlstones? Could the comparison of a very recent arenaceous bed with some old secondary sandstones be considered as extraordinary, when this similarity does truly exist?

If accessary circumstances, as the different extent of the sea, the vicinity of various formations, and many other causes, are enumerated, as having produced the differences in all the various arenaceous Neptunian deposites, why should we not employ the same arguments in explaining the anomalies observed between old and modern igneous formations, especially as it is only necessary to explain the frequency or rarity of a particular circumstance in two similar deposites? Who can, besides, assure us that these pearlstones and porous rocks may not be found in much greater abundance in some old secondary pitchstone tracts of country

We must add, also, that the absence of pearlstone in old pitchstones is quite natural, for we know that vitreous matter presents a similar concretionary structure only in the case of a certain slow cooling. Now, may it not be plausibly supposed, that the accessory circumstances of the trachytic deposits have been very favourable to the production of this particular structure; and that, on the contrary, those which have happened at the period of the old pitchstone formation, have been in no degree favourable to the formation of this variety of vitreous product, as well as to that of the very porous vitreous rocks?

The question, then, is always hanging upon some trifling circumstance of no essensial importance; and I believe I have already sufficiently shewn how little weight those pretended Neptunian proofs have, which are elicited from the comparison of two species of vitreous deposites.

M. Beudant next proceeds to the *porphyries*. He assures us that some of these rocks in the neighbourhood of the old secondary pitchstones have often a great similarity to certain varieties of trachyte. In another place, he says that the secondary porphyries present a pretty well marked analogy with the trachytic porphyries, and his *porphyre molaire*, (p. 199); and he adds, further, that some masses of porphyry would, from their characters, lead one to suppose them of volcanic origin, while others again impress the idea of a Neptunian one. Now, I shall agree with M. Beudant in saying, that the one and the other must necessarily have had the same origin; and it will only be requisite to shew, in such of the porphyries as seem to be of aqueous origin, a sufficient number of igneous characters, to be able to attribute to these the same origin as to the other class.

In the first place, these porphyries present scoriaceous or porous portions, which seem to me to demand a much greater attention than M. Beudant seems inclined to bestow upon them, for these varieties are not always distributed without a certain order: they are to be observed principally in the upper, and less frequently in the lower parts,—an observation which I have fully verified, contrary to the assumption of M. Beudant, as well at Hallé, as in the Thuringerwald, the Erzgebirge, Scotland, &c. Besides, these porosities have exactly the form of those of the igneous deposites, and are in no way to be compared to those.

of aqueous deposites, a point which I have sufficiently elucidated in my Essay on Scotland.

On the other side, again, the best proof that M. Beudant imagines he gives of the impossibility of the igneous origin of porphyries, is, that "they are mineralogically similar to the porphyries, which form beds in gneiss and mica-slate," (See *Voyage*, &c. vol. iii. p. 200). This comparison is, in the first place, contrary to sound reasoning; and, in the second, erroneous and fallacious;—contrary to sound reasoning, because it is comparing a problematical product with one of which the aqueous origin is purely a hypothetical assumption; for, if the gneisses and mica-slates were even indisputably aqueous products, which is by no means proved, it would not necessarily follow that the porphyries should have the same origin, when it is acknowledged that basaltic masses alternate with beds of tertiary coarse marine limestone, or fresh water deposites. If M. Beudant deny this fact, or if he will not believe the geologists who have seen these alternations, nothing will be able to make him change his opinion but the inspection of the contested localities. But, besides, the comparison is quite fallacious, because those pretended porphyry beds are only a sort of more or less singular veins; they are masses connected with extensive old porphyritic deposites, as I have satisfactorily shewn in the Erzgebirge, (See my Memoir on Germany in the *Journal de Physique*, 1822); and hence the pretended primitive porphyries are similar to those of the red and coal sandstone. These veins show the geognostic position and singular appearances of basaltic dikes, and easily deceive, when they are included in mica-slate or gneiss nearly parallel to the plane of stratification of the beds; but if it were possible to follow them over a great space, one would soon become aware of their true nature.

I may add, also, that I deny most positively the *true passage from a porphyry into a sandstone*, to which point M. Beudant could have given more importance than he has done. This transition (referred to at p. 193), is only apparent or quite accidental: it is a sandstone united by means of a feldspathic breccia with a porphyry, or a sandstone intimately connected with a feldspathic agglomerate, which, by a very compact re-aggregation, presents in certain parts the false appearance of a porphyry, as is often to be seen in trachytic agglomerates.

Lastly, M. Beudant adduces as a proof in favour of the Neptunists, the comparison of the old porphyry masses, which appear to lead to the igneous idea, with those porphyry masses which seem to sanction the Neptunian idea of their origin; and he concludes, from the predominance of the latter, that the Neptunian probabilities are greater than the igneous ones. I am sorry to be obliged to say that this reasoning is altogether false, being founded on erroneous views; in fact, M. Beudant has not himself visited all the porphyritic countries, which he looks upon as evidently of Neptunian origin,—he has only read their descriptions, or seen specimens of them. Had he examined them, he would have found that the Thuringerwald contained scoriaceous and porous porphyries in abundance; that at Hallé a great many igneous appearances are exhibited in the porphyries, which were unknown or neglected through a preconceived Neptunian hypothesis; and, lastly, he would have been able to see the same phenomena in the Rhine countries, and even the Erzgebirge would have furnished him with most surprising igneous appearances *.

I imagine I may now also conclude, in contradiction to M. Beudant, at least if I adopted the necessity of the principle which he expresses, by saying, that "the porphyry masses leading to igneous ideas being much more numerous than those which lead to the contrary opinion, the igneous probability is far greater than the Neptunian one."

Our author goes from the porphyries to the *basaltic rocks*; he perceives, on the one hand, a great analogy between the modern basalts and those of the older red sandstones, of the greywacke, and even of the mica-slates; he sees every where the same prismatic structure, the same other particular forms, and the same augite: but, on the other hand, he soon observes that there is no *olivine* in ancient basalts, and that this mineral exists always in modern ones, when they are examined over a sufficient extent of country. (P. 201.)

In the first place, I most positively deny this last proposition, unless M. Beudant understands by a *sufficient space* the basalts of a whole group; and, besides, how often are not cones and

* See my Memoir in the *Journal de Physique*, for 1822.

tertiary basaltic streams to be seen, where olivine does not exist, while, at the same time, it abounds elsewhere? Such instances occur in the Mittelgebirge, about Eisenach, in the Rhongebirge, &c. Olivine is certainly characteristic of the recent basalts, but it is nevertheless found also occasionally in ancient basalts, in contradiction to M. Beudant's assumption, and it exists there especially decomposed, or as limbilite. Every body knows that this substance is rather easily decomposed;—and why, then, should it be deemed a matter of surprise not to find it in its original state in so ancient igneous deposites? But happily we do not want the presence of this mineral to show the igneous origin of ancient basalts,—we do not even require to take notice of their augite: the porosities, the appearances and geognostical position of old basaltic rocks, are our unanswerable proofs of their igneous origin. Is it not clear, then, that these Neptunian proofs vanish of themselves, and that we have only to prove the truth of our assertion?

With regard to the *amygdaloids*, it would seem that the author of the *Voyage en Hongrie* had not paid sufficient attention to the nature of these rocks, when he positively denies that they constitute the upper or under parts of igneous masses. (P. 198.) I admit, with great pleasure, that he may be right in as far as concerns the amygdaloidal masses observed by himself; but I assure him that he would err egregiously did he wish to generalize this particular observation, for I could without hesitation point out a dozen of places where this phenomenon is perfectly well seen; for instance, on the Fife coast in the coal-field, on the Kincardineshire coast in red sandstone, at Planitz in red sandstone, at Prague in transition-slates, &c.

In contradicting M. Beudant, I do not by any means contend, that what I have just stated is always and invariably the case, any more than I would assert that lava-currents or basaltic dikes have always their upper or under parts evidently scorified; all this depends upon accidental circumstances: but I shall only observe to him, that the amygdaloid pretty generally takes the place of those scorified parts, or that they are very porous basaltic rocks, infiltrated afterwards by various substances, which is entirely conformable with the observations of true basaltic lava streams. I comprehend perfectly how, in examining solitary

amygdaloidal masses in particular, one may be inclined not to look upon them as scorified infiltrated parts, because their limits with basalts are sometimes pretty decisively marked for a short space; but if this limit be followed, one soon becomes aware of their true nature. This is evidently exemplified every year by Professor Jameson in his practical illustrations of geology along the Fife coast, a locality which, together with that of Prague, I would earnestly recommend to the study of M. Beudant.

This idea once admitted, it will no longer appear so singular for M. Beudant to see amygdaloids in connection with porphyries, to observe these rocks in an earthy state, and to be obliged to suppose them every where decomposed in the same way. Indeed, why should this alteration be different in different places? Would not this be contrary to nature? And do not the lavas undergo alteration, especially in their porous and scoriaceous parts? Is it, besides, well demonstrated, that these wackes, or the bases of these amygdaloids, always owe their earthy nature simply to an alteration? and have we not, on the contrary, some facts, which would tend to show that this nature depends, in some measure at least, upon their primitive state, I mean upon the matters which gave rise to these products?

We see that it is by no means impossible to make the proposed difficulties vanish; and one perceives with pleasure, that, notwithstanding all this, the same geologist admits not only the great similarity of amygdaloids and infiltrated basalts, but also that of the minerals disseminated in both rocks.

Resuming a comparative view of the facts and arguments adduced, it will now seem clear to every impartial mind, 1*st*, That the mineralogical analogy of some varieties of secondary pitchstones to some others of volcanic pearlstone and pitchstone, and the presence even of only small masses of scoriaceous parts in the older pitchstones, are proofs of the igneous origin of these last; and that, on the contrary, their aqueous formation can be supported by no mineralogical proof whatever, deduced from what is clearly known respecting them.

2*dly*, That the presence of scoriaceous parts in porphyry and greenstone deposites, the local formations of porphyries entirely analogous to volcanic products, and their decided separation from the aqueous or mechanico-chemical deposites, show most

evidently that they are igneous formations, which cannot in the least be explained as having been produced by the aqueous mode.

3dly, That the amygdaloids being intimately connected with the porphyries and basalts, they are also evidently of igneous origin.

In short, it is infinitely probable that all the preceding rocks are of igneous origin, and there is not a single probability that they are of aqueous origin,—a proposition which will ultimately be victoriously proved, "*malgre le déli de M. Beudant,*" (p. 203), by the best argument, the *argumentum ad hominem,* viz. *the geognostical position of these masses.*

It is acknowledged that the pitchstones are every where associated with deposits of red sandstone, and that they form amongst these rocks, contrary, I am sorry to say, to M. Beudant's assertion, *veins* *, *imbedded masses,* and even *short beds,* (if this concession can afford any pleasure). The pitchstones in old red sandstone, which have hitherto been detected in Europe, are, those in the Isle of Arran, and some other parts of Scotland, at Mohorn, in the Valley of Trebitschthal, at Planitz, and at Grantola. Some lithoid varieties have also been observed around Freyberg, in the Thuringerwald, and a similar variety, passing into the feldspathic basalt, is found in the Palatinate. These are the only known localities of this rock. All these I have visited, excepting the problematically situated mass of Grantola; and in all these places I can confidently assert that their geognostical position is such as I have represented it above. In Arran, the pitchstones form *veins;* and it is most singular to see M. Beudant holding out that pitchstones are never found in such a position, when, besides myself, Professor Jameson asserts and minutely describes the fact. Let me be allowed to ask from whence can arise this disbelief of the truth? Perhaps we may not altogether be wrong, if we imagine that we perceive here the predilection for a favourite idea, which has escaped against the author's will. Nevertheless, it is clear, from his work, that he looks upon the basaltic veins as igneous products elevated in the

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* See M. Beudant's *Travels,* p. 203, where he says that pitchstones are never in veins.

Plutonic way; so that he would almost assuredly have been obliged to adopt the same idea with regard to the old pitchstones, had he admitted that they existed in veins.

At Planitz, in some localities in Scotland, in the Thuringerwald, pitchstones form *imbedded* or *wedge-shaped masses*. In the Trebitschthal they present themselves in the form of a great imbedded mass, or a kind of short bed; and, in the Palatinate, they have the form of a more decided short bed. The masses or short beds at Mohom are situate in tuffaceous beds, limited to a small space, of which the base is more or less argillaceous, and contains rolled masses of gneiss, &c.; and the pitchstones show also these fragments of gneiss, which have been accidentally inclosed in this rock at the time of its elevation, an appearance similar to that presented by a pitchstone-vein in Arran. In the Valley of Trebitschthal the pitchstone-mass rests upon porphyries, with which it is of contemporaneous origin; their superior position and their nature has enabled them to cool more rapidly. In the same valley small pieces of pitchstone are imbedded in the tuffaceous sides of the porphyry-vein at Tanneberg *. At Planitz the vitreous mass seems to traverse the red sandstone, and not to have been far from the central volcanic action. In the Thuringerwald, and in the other points of the Erzgebirge, the masses of lithoid pitchstone are associated with porphyries, and pass into them; they seem only to be parts sooner cooled than the rest. In the Palatinate, the black pitchstone of St Wendel forms a kind of short bed or mass upon sandstones; it is associated with porphyries, and presents igneous appearances; one can scarcely decide whether it be a vein or a kind of stream. To this point alone could be referred M. Beudant's account of the alternations of pitchstones, sandstones, coal sandstones, and slate-clays. It is evident that he ought to have mentioned the accessory circumstances, and not speak of these alternations as if the pitchstone were a rock alternating with sandstones, as the slate-clays do, and with the same frequency as these latter rocks.

Having in this manner attempted to appreciate the alleged alternations of pitchstone and arenaceous rocks, we see nothing

* See my Memoir on Germany.

that can hinder us to infer the igneous origin of the former of these rocks, unless the obscure position of the St Wendel pitchstone. Now, were it even proved that this mass forms a short bed, it would only appear as a kind of stream, or a bed-like vein, among sandstones, in the same manner as the basalts are seen in streams or in bed-like veins among calcareous or argillaceous formations, in the Vicentin, Sicily, Auvergne, Scotland, and elsewhere. This observation is equally applicable to the difficulties which M. Beudant finds in the alternations of secondary basalts and sandstones.

It is a matter of fact, that, in Silesia, in Scotland, in France, Germany, &c. such alternations exist; but I have already shown in my Essay, that these alternations are only included in a short space of ground, and that they cannot be observed beyond certain limits. After this, one cannot but be astonished to find M. Beudant asserting that they pervade the whole extent of a formation; whereas the fact is, that they only appear in a formation in the form of more or less extended and unconnected patches. If it be admitted by all geologists, that the face of a hill or a short space has often given rise to the idea of alternations of true basaltic beds with sandstone, what geologist has ever been able to trace a single basaltic bed through a whole local sandstone formation; and where, in the whole annals of science, do we find recorded a single instance of the kind?

Besides, on examining these very alternations, one finds that the number of short beds forming streams or vein-like beds diminishes much, for most of them, after a scrupulous examination, turn out to be only various kinds of veins; for instance, Salisbury Craigs, Lichtenberg district, &c.; and often the short beds have the appearances of those masses elevated at once from below, as at Stirling Castle, Perth, North Berwick Law, Edinburgh *, &c., or the matters have extended themselves to a short distance from the orifice through which they were elevated.

These appearances only present great difficulties of explanation. If we comprehend among these alternations the beds of wacke and of trap-tuffa, we then naturally find it difficult to explain the igneous origin of so many beds of only a few feet in

* See Professor Jameson in *Wernerian Memoirs.*

thickness alternating with rocks evidently arenaceous, as at the Calton Hill, &c.

But geologists accustomed, like M. Beudant, to distinguish with so much accuracy the immediate products of volcanoes from those which are only results of aqueous destruction and re-aggregation of igneous matters, will find these alternations quite natural; nor will he be at all astonished to find them extending over a great space, although this space will never equal the extent of the common subordinate beds of the sandstone formation; and this phenomenon will only furnish him with an excellent argument for maintaining that these igneous deposits have taken place during the formation of the sandstone deposite, in the same manner as the conchiferous basaltic tuffa of the Veronese, alternating with tertiary beds, shows that basaltic eruptions have happened during that period of time.

Yet M. Beudant finds it extraordinary that these igneous matters should have been able to introduce themselves in such a way among Neptunian arenaceous rocks. This is not a little surprising; for I may venture to predict, that his able description of trachytic districts will soon induce geologists in general to extend with me the igneous domain. It may even be said, that the Wernerian idea of restricting volcanic productions to existing volcanoes only, was much more consistent with sound logic, than to extend the empire of Pluto to the extinct volcanoes and trachytes, and to stop there. In short, the geological thermometer must rise to a degree indicated by Nature, and not by partial views of natural phenomena. I can scarcely believe that M. Beudant should in reality doubt the alternation of basalts with tertiary deposites, for it is a fact too well determined to admit of dispute; and those who believe it, or who have seen it, will see nothing extraordinary in the alternation of older basalts with sandstones.

The *geognostical position of porphyries* has the greatest relation with that of trachytes; they often form bell-like hillocks or *domes*, composed of concentric circular layers; as, for example, near Freyberg, Halle, &c. one might fancy himself in front of the Puy of Sarcouy, in Auvergne. In other places, they rise, like certain trachytic districts, into conical and acuminated hills, which are sometimes as striking, on account of their isolated po-

sition, as the trachytic mountains; but if the porphyritic masses have been but small, they form only nearly vertical, cylindrical, or wedge-shaped masses, like the submarine basalts of Eisenach, Moravia, Hungary, &c.

Porphyries are situate in hillocks, associated with some kinds of porphyritic streams or protuberances, upon primitive and transition rocks, upon the coal sandstone, upon the *todliegende* or newer red sandstone, and upon the first flœtz limestone. All these formations are traversed by porphyry veins, or cylindrical bodies of the same rock, as is so clearly seen in Scotland, the Erzgebirge, the Alps, &c.; here and there only the veins have accidentally formed short beds or imbedded masses in the Neptunian deposites.

Lastly, porphyries are often connected with sienitic and granitic hills, or immense cylindrical or wedge-shaped granitic masses or districts, and sometimes include more or less considerable portions of older rocks, in some instances elevated, or dislocated, or even altered. Ben-Nevis, the highest mountain in Britain, presents such a connection with sienite; and Dr Macknight's characteristic description of that hill and its neighbourhood testifies most amply its igneous elevation.

After adducing all these facts, which I look upon as of a very superior kind, I might conclude these pages with nearly the same words as Mr Beudant, did I not think them rather too strong; and yet, for the benefit of science, while, at the same time, I have no inclination to diminish the high degree of credit which my opponent so justly deserves, I shall here transcribe his conclusion.

" After all these facts," says M. Beudant, " which I look upon as of a very superior kind, I am of opinion that none of the observations which have hitherto been adduced as tending to the adoption of the igneous (I might say aqueous) origin of the felspar and basaltic rocks of the red sandstone, even allowing them all the weight which they have not, could prevail over circumstances of position, so generally diffused in nature, and so well established by the great majority of geologists."

If, after the exposition of similar facts, the igneous (I might say aqueous) origin is still to be admitted for the crystalline rocks subordinate to the coal sandstone or the red sandstone, it

it must in like manner be admitted, that *all the crystalline and arenaceous rocks which constitute the crust of the globe* (I might say all the crystalline rocks which enter into the composition of the crust of the globe, and even the trachytic and basaltic rocks) are also formed *by fire* (I might say by water). The fabric of the science will then be overturned, and the science itself rendered subordinate to a favourite system, while error will thus occupy the place of truth.

In the present state of science, and without entertaining any prospective views, it is extremely obvious that the probabilities are much in favour of the hypothesis of an aqueous (I might say igneous) formation. It would tend to diminish, instead of advancing, science; and return it to its infancy, to admit any other opinion, so long as new facts could not be thrown into the balance of probabilities.

The whole of this conclusion applies equally, and *à fortiori*, to the amygdaloids of the grey-wacke, as well as to the green-stones and the porphyries which accompany them.

ART. XI.—*Journal of a Tour to the Coast of the Adriatic Sea, and to the Mountains of Carniola, Carinthia, Tyrol, Saltzburg, and Bohemia, undertaken chiefly with a view to the Botany and Entomology of those countries.* By Dr DAVID HENRY HOPPE and Dr HENRY HORNSCHUCH. (Continued from vol. ix. p. 353.)

"*Hundsberg, April 24.*—THE laying out of the beautiful plants that we last brought home employed us during the whole of yesterday; and, as it also emptied our botanizing boxes, so we determined to replenish these with an abundant stock of *Mercurialis ovata*, for our collection. Accordingly, we hastened this morning direct to Contobello, and pursued the "buona strada" without much delay, though, as we went, we observed in flower the hairy *Lotus corniculatus*, and *Carex distans*. also *C. glauca* of Scopoli, and *C. præcox* of Jacquin. We likewise found a singular plant. whose name we cannot at present determine. It is an *Apargia*. Probably Scopoli has included this species under his *A. hispida* or *hirta*; but it

certainly is not the first, and the latter has always appeared to us to be a doubtful plant, which, though mentioned by all authors, is far from being certainly known. Its leaves have the form of all its allied species, but they are narrower, bristly throughout, with the bristles trifid; the stem is much longer and slenderer than in *A. hispida;* the calyx differently formed; and its yellow petals are red on the outside. Here also grew *Hieracium auricula*, *H. pilosella*, and an *Æcidium* on leaves of an unknown *Scorzonera*. *Globularia vulgaris*, and the *Astragalus*, which we lately found,' were plentifully in flower. We now ascended to the top of the mountain to botanize. We saw *Thymus Serpyllum var. angustifolium*, *Thlaspi præcox* with an *Æcidium*, *Glechoma hederacea* with very hairy leaves, and *Thlaspi saxatile*. We soon reached a very stony tract, covered with bushes, where many plants just appeared; for instance, *Carex alpestris* Willdenow, *C. Michelii*, *Pæonia officinalis*, *Convallaria Polygonatum*, *Hieracium auricula*, *Orobus vernus*, *Rhus cotinus*, *Dictamnus albus*, and an umbelliferous plant, new to us, and not yet in flower, with large, much divided, rigid leaves, the segments very narrow, and like those of *Athamanta Meum*. *Lamium maculatum* was everywhere in blossom, having spotted leaves; whereas, in our Salzburg specimens of this plant we always find them plain. At last we came to our much admired *Mercurialis*, which grew plentifully under bushes, on stony ground. *Potentilla subacaulis* was its neighbour, on grassy hillocks, in open spots. We now ascended nearer to the summit, and then arrived at a delightful place, where the *Melittis* with white flowers abounded, which Smith * has given as new. *Asclepias Vincetoxicum*, *Orobi*, *Lathyri*, and many other plants, now appeared, when at last one of us, with great enthusiasm, cried out *Sesleria tenuifolia*, and the other responded, in like manner, *Fraxinus Ornus!* *Euphorbia Characias*, which grew plentifully and in great luxuriance, gave us reason to observe that Wulfen's spring had now commenced.

Here we sate ourselves down, to enjoy the delightful view of the Adriatic Sea, to partake of some sweet oranges, which supplied the place of a dinner, and to examine, more attentively,

* *Melittis grandiflora* of Engl. Bot.—Ed.

the beautiful *Flowering Ash*, which, in its habits, may be likened to *Sambucus racemosa*. As this shrub grows plentifully here, we named this grove The Manna Wood, although we are aware that no manna can here be collected from the trees. On descending, we came to a very stony place, where two plants rivetted our attention, the *Ajuga genevensis*, with quite smooth, almost succulent leaves, and a *Euphorbia*, which we were inclined to consider the *verrucosa*, but which Host informs us to be the *E. epithymoides*.

Some untoward circumstances occurred in this day's excursion. Most of the time it rained. As we were digging up the *Apargia*, an Italian peasant drove us away; and we met with some mischances in descending from the Manna Wood. The mountains here are extremely steep. We could scarcely help falling at every step, whereby stones of a hundred-weight in size were set in motion, and fell down into the vineyards below. These, we dreaded, might cause the death of some individual, and assuredly would damage the trees and vines; and, if even these circumstances might not ensue, it was very important to us not to throw stones into the gardens of the persons who had hitherto permitted us to climb their walls, and to pass through their grounds without molestation. Happily we were noticed only by a couple of girls, who appeared to be highly delighted in seeing our perplexity, and who laughed heartily at every fall that happened to us.

" *Hundsberg, April* 26.—We were again compelled to devote a day to laying out our plants. Our *Astragalus*, according to Host's Flora, should be the *A. incanus* of Linnæus, as the habitat given for it is the *Ager Tergestinus*; but its entirely smooth leaves contradict such an opinion. We departed early this morning to visit our favourite Wood of Lippiza, our expectations being raised by hearing from our friends Brandenburg and Gerop, who had just been there, that, in one of the basin-like hollows, *Narcissus poeticus* was in flower. In high spirits, therefore, and without regard to the difficulties of the ascent, we hastened to Monte Spaccata, and had the pleasure to find, on the top of it, and under bushes, several specimens of this beautiful plant. The sight of them rejoiced us so much, that we could hardly refrain from laying hands on them instantly. We, however,

pursued first our way to the Wood of Lippiza, to see what Flora had there prepared for us. Taking the road thither by the meadows that enclose the wood, we found these to be entirely covered with another garden-plant, *Hyacinthus botryoides*, which presented a charming spectacle. On the stony plain, the pretty *Potentilla subacaulis* flowered in great quantities, and gave a somewhat more cheerful aspect to this dismal tract. Vegetation was still more backward in the wood itself; and, except some plants of the beautiful *Narcissus*, we found nothing of any consequence; but we observed, with pleasure, what trouble our friends had given themselves yesterday, in order to procure us some beetles. Every stone had been turned over; even the dung-heaps were not spared; and we were extremely sorry that the pains of our kind companions had not been rewarded by greater discoveries. On our way home, we found, near the village of St John, a large tree of the *Carpinus*, now in full flower, which we had seen some time since near Duino.

"*Hundsberg, April* 27.—Before we went into the city to-day to attend to our usual Saturday's employment, we made a little excursion to the foot of Monte Spaccato, to collect specimens of the *Carpinus* which we had noticed yesterday. Happily we had got a sufficient quantity of individuals, and were just descending from the grove, when a countryman joined us, and informed us, civilly however, that the tree was his property. On the way to the city, we observed, with pleasure, that the *Manna Ash* flowered plentifully in the adjacent gardens. The children were carrying home their arms full of it, to put into jars of water in the windows, as we are accustomed to do with lilac. Much as we were gratified by observing this custom, we were yet more surprized at the sight of a group of trees, among which we detected the grand *Carpinus* that we had seen at Parenzo, which, in spite of the great heat, yet glowed with its lovely rose-coloured male catkins. As these were going off very fast, a considerable number of them must be collected immediately. We therefore dispatched our city business as quickly as possible. It is singular that we should yet remain in doubt as to the characters of these two species of *Carpinus*, but their future fruit must decide the differences between them.

"*Hundsberg, April* 29.—Yesterday forenoon was spent in

turning over our plants; and, as it is agreeable to rest after such labour, so we were enabled to dedicate the after part of the day to the visiting of our friends, whose number begins to increase. We went also this morning to the territory of Contobello. We found, on our way thither, among the first vineyards, under the stones, an *Julus*, of considerable size, and in no small numbers, which is unknown to us. Besides the natural odour which it yields, something like phosphorus, or, as one of us expressed it, resembling the acid vapours of saltpetre, it possesses the power, on being touched, of exuding a liquor, by which the skin is immediately tinged of a yellow colour. The number of its feet is so considerable, that to count them on the spot was impossible. We found, besides, a beetle that had been trodden on, which, in spite of this great mutilation, was immediately recognized by us as the rare *Carabus catenatus*. We could almost have been angry with the person who had thus deprived our collection of it; for it would be scarcely possible to unite the parts again, so much are they injured. We now proceeded to the sea-shore, and every where saw Flora in all her glory. All the plants that we have before observed are now in great perfection; and, amongst them, *Coronilla Emerus* is distinguished by its numerous and brilliant flowers. On the hill above the "buona strada," we saw numerous oaks in great vigour, and a shrub with entirely red pinnated leaves and flowers, as yet rolled up in bud, both of which are unknown to us. The oak is common here, and is perhaps either the *Quercus Ægilops* of Scopoli, or *Q. Cerris* of Host. The other beautiful shrub is probably a *Rhus*, of which, as far as we can remember, some species are of two sexes. When we had collected sufficiently here, we returned to the Manna Wood, where *Flora* appeared in full perfection. We gathered the beautiful *Orobus*, which was now plentifully in flower; a couple of *Lathyri*, *Euphorbia Epithymoides*, which grew every where about, on stony places, and in great bunches; and a yellow flowered *Alyssum*, like *A. montanum*. To-day we were more especially enabled to do homage to *Fauna*; for we found, on the young leaves of some trees, particularly of the oak and the manna ash, many *Curculios*, among them *C. Gorzensis*, and *C. planatus*. Zealous entomologists may guess the pleasure which we felt, when I inform them, that these two species

dropped from the branches by hundreds, when they were slightly shaken.

After we had, in this manner, sufficiently enriched ourselves, we returned home to our habitation, at a very late hour, happy in the success which had repaid our labours.

" *Hundsberg, April* 30.—The Emperor is arrived to-day in Trieste, and was received with great ceremony, amidst a vast concourse of people. We remained in the house, engaged with our plants and beetles; and, in the afternoon, visited a spot near us, as a new field for botanical research. We took a path which led from the village of St John, through woods and vineyards. The former consists of underwood, and extends so far as to be lost in the Karsch. It is a glorious botanical tract, which promises amply to reward our investigations. We named it the Chesnut Wood, because many of the true *Chesnut Trees* grow there. Although the Triestiners appear to be quite ignorant of the existence of these trees near them, yet they purchase their fruit roasted in the markets, without troubling themselves with a single inquiry as to whence they are brought We found the following plants in flower:—*Scrapias ensifolia, Lithospermum purpureo-cœruleum, Melittis grandiflora,* and *Tamus communis.*

" *Hundsberg, May* 2.—*Country Custom.*—The first day of May is, in Trieste, as well as in many other places, a day of gladness, as, at that period, mankind rejoice in the return of spring. We had yesterday an opportunity to observe the celebration of this festive period, as the suburb of Hundsberg is the spot where it takes place. Early at day-break, the procession of the Triestiners commences to the Grove of the Hundsberg, which is soon filled with thousands of people, in all conditions of life, dressed in their holiday suits, enjoying themselves in the open air. They breakfast, take walks, and gather young branches from the oaks, which they carry home to decorate their houses. As all this took place under our windows, and our friends were among the number of the pleasure-takers, we presently joined them, and passed a very happy morning. Since all the merchants must be at their counting-houses by eight o'clock, and every thing here depends on trade, the cheerful multitude dispersed at that hour, and quiet returned to the peaceful grove. Our host cal-

culated that, in this short space of time, he had disposed of 800 portions of coffee.

In the train of the Emperor was M. Antoni, the Royal gardener. He had inquired if there were any persons who knew the country around Trieste, as far as respected its botany; and he was referred to us. Thus we made this gentleman's acquaintance; and this day's excursion to Saule was enlivened by his company. We found some rare plants as well as shells; but, as we could not collect these in sufficient quantities, without neglecting the conversation of M. Antoni, so we resolved to make this excursion again to-morrow. On our return, a spectacle of a kind novel to us, though common in this country, attracted our attention. The women and girls of Istria always bring their goods to market upon asses. On their return home, particularly when the weather is hot, they avail themselves of the opportunity to ride which these animals afford; but, as this is done without any more suitable equestrian garb than a single garment of scanty longitude, and only bound round the waist with a kind of girdle, so this cavalcade presented such a sight as caused the old gentleman, our companion, to pass several jokes, and compelled him to many a hearty burst of laughter.

"*Hundsberg, May 3.*—*Aristolochia rotunda.*—We did not delay a moment to-day in commencing a search for those rarities of the vegetable kingdom which we saw yesterday. The first plant whose turn it was to be unmercifully rooted up, was a *Carex spicis androgynis, spiculis superne masculis, inferne fœmineis, culmo nudo, radice nodosa repente.*

The resemblance of this grass to *Carex Schreberi*, did not escape us at the time; but, as its root was thick and knotty, we thought of *C. chordorhiza*, Ehrhart. After a closer examination, and a comparison with Willdenow's *Caricologia*, we should have decided it to be *C. schœnoides*, if we had not found this species, as we believed, formerly in Istria. As we have now gathered a sufficient quantity of this plant, it shall be added to our publication on grasses, when the true character will be given. It grows on dry sandy ground, near the sea-shore. A second plant was *Orchis variegata*, which grows plentifully on dry meadows before Saule, and of which the first sight yesterday gave us no small gratification. We took it then to be a variety of

Orchis militaris; but we are now satisfied of the contrary, and believe it to be a true species, which is not a native of our country. The wet meadows near the sea, by Saule, possess many charming plants. Here grow *Leucojum æstivum*, which we had seen sold in bouquets at the flower-market of Trieste; *Scirpus maritimus β compactus*, Hoffman; *S. Tabernæmontanus*, *Triglochin maritimum*, *Lotus siliquosus*, *Carex distans*, and *C. vulpina*. We gathered at a brook *Scirpus palustris* with long, thick, compressed stalks, which spring singly from a creeping root. It is certainly different from the plant which goes under the name of *S. multicaulis*. On a bank by the beach, the rare *Aristolochia rotunda* at length smiled upon us in fine flower; and, on the sandy hills, we were sometimes lost amidst the flowering bushes of *Coronilla Emerus* and *Cratægus monogyna*, which grow here in great profusion. On airy declivities grew, out of a sandy soil, the plant which Wulfen has incorrectly termed *Plantago subulata*; and, under shrubs, *Arum italicum* was just expanding. Our vascula were soon filled with these rarities, and our day's employment was early terminated. On our return to our apartment, we had the pleasure of a visit from our friend Brandenbourg, who informed us that he had seen, in a field near the road from Obschina, a curious plant, but that he had lost the specimens of it in his way home. From the description which he gave us, we immediately concluded that this flower must be the *Aristolochia rotunda*; and we shewed him the individuals that we had just gathered. The general appearance M. Brandenbourg pronounced to be similar to *A. rotunda*; "but" said he, "still the inflorescence is of a different and much paler colour." At these words, our conjectures immediately turned to the *Aristolochia longa*; and one of us having hastened to the spot, which was pointed out, actually brought back this plant, and also the *Vicia grandiflora* of Scopoli.

"*Hundsberg, May* 4.—With the first beams of morning we rambled through St John's, to make another visit to the silent grove of Lippiza. It was a glorious sunrise; such as had the beneficial effect of raising the human mind to the most lofty aspirations; and it led us to anticipate a successful excursion. The birds saluted us with their lively mattins from the boughs of

the full flowered *Manna Ash*; whilst the soft southern breeze loaded with the charming perfume of flowers, particularly those of the numerous almond and peach trees which decorate the vineyards, refreshed us with the most delightful fragrance.

We had scarcely reached the top of the Monte Spaccata, under the influence of these agreeable feelings, and trod the stony fields near Eggenhofner's Cave, when we were delightfully surprized by the sight of millions of *Narcissus poeticus* in flower. It gives singular pleasure to find, growing wild, even a single specimen of a flower which one is accustomed to behold only in gardens; but to discover, in the greatest profusion, flowers of such beauty, filling the whole country with their delightful scent, produces an extacy which must be felt, but cannot be described. The Poets, whose mention gave to this plant its trivial name, could not surely have celebrated it from viewing a single blossom in a state of cultivation, but from seeing whole meadows covered with it in their southern climes. This *Narcissus* belongs to those plants which have had the right of citizenship of gardens from time immemorial, like the *Wallflower*, the *Stock*, *Hope*, &c. and others, which, at all periods, have claimed the privilege of being considered eligible candidates for the public favour in gardens.

To complete our gratification on this occasion, another familiar flower presented itself to us, namely, that delicate chequered blossom, the *Fritillaria Meleagris*, which grew in numerous patches close by the bushes, and amongst the *Narcissi*. Happy is it for us, that, although destitute of those poetical powers which have formerly celebrated the charms of these plants, and painted, in lively colours, the glowing beauty of the flowery landscape, we have yet sufficient sensibility to appreciate the glories of this day. We found on the path, upon masses of grey limestone, the beautiful *Lichen marmoreus* of Wulfen; and, in dung-heaps, many specimens of *Gymnopleurus pilularius*, Sturm, both in a small and large state. In similar situations, in the wood, were some very beautiful *Scarabæi*, particularly *S. vernalis*, with *elytra* of a shining golden green colour; and, in hollows, under old decayed leaves, we had the gratification of detecting an undescribed species of this genus. This new *Scarabæus* differs, by having a smooth spineless helmet, in which re-

spect, as well as in its mode of life, it is also distinct from *S. sylvaticus*, to which, in other particulars, it has a considerable affinity. Two very perfect specimens of *Carabus catenatus* fell into our hands alive. Of less value were *Rhagium mordax* and *Lamia curculionoides*, which we saw upon young branches of shrubs, and *Carabus convexus*, which we found under stones.

(*To be continued.*)

ART. XII.—*Account of Captain* BASIL HALL'S *and Mr* HENRY FOSTER'S *Experiments with an Invariable Pendulum, made near the Equator, and on the Coasts of Mexico, and Brazil* *.

WHEN Captain Hall left England in 1820, in his Majesty's ship Conway, for the South American station, an invariable pendulum was, at Captain Kater's suggestion, put into his hands by the Board of Longitude. As the service, however, upon which this officer was sent, was unconnected with scientific objects, it was only at particular intervals of active professional employment, that he could command the requisite leisure for philosophical inquiries. Through the indulgence, it appears, of Sir Thomas Hardy, Bart. K. C. B., the commander-in-chief, he was enabled to make three sets of observations with the pendulum, viz. at the Galapagos, a group of islands in the Pacific Ocean; at San Blas de California, in Mexico; and at Rio de Janeiro in Brazil.

The Galapagos Islands being under the Equator, Captain Hall was desirous of making his observations exactly under that great circle; but, from the ship being swept to leeward in the course of the night, and from the small number of days which he was allowed to spend at this place, he was forced to take a station at the south end of Abingdon Island, formed of lava, and about $32\frac{1}{2}$ miles north of the Equator.

The longitude of the station was $90\frac{1}{2}°$ W., and its latitude 0° 32′ 19″ N.; and the number of vibrations made by the pendulum, in a mean solar day, was 86101,34, at the level of the sea, *in vacuo*, at 68° of Fahrenheit. As the same pendulum in Lon-

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* These experiments are published in detail in the *Philosophical Transactions* for 1823, Part II. p. 211—289.

don, in 1820, made 86285,98 vibrations in the same interval, it follows, that the length of the seconds pendulum at Galapagos, is 39,01717 of Sir G. Shuckburgh's scale, the length of the seconds pendulum in London being assumed at 39,13929.

By comparing this result with those obtained by Captain Kater at the different stations of the Trigonometrical Survey, (as already given in this *Journal*, Vol. II. p. 321 and 322), Captain Hall finds that the

Mean diminution of gravity from the Pole to the Equator, is	.0051412
The mean Ellipticity, ...	$\frac{1}{284.98}$
The Mean Ellipticity, as deduced from Captain Sabine's observations at Melville Island, is . .	$\frac{1}{292.14}$
Length of equatorial pendulum, . . .	39.017196.

San Blas, where the second set of observations was made, is a sea-port town of Mexico, in West Longitude 105° 15′, and North Latitude 21° 30′ 24″. The station was 115 feet above the level of the sea, and on the summit of a rock of compact whinstone. The number of vibrations made by the pendulum, in a mean solar day, was 86125,03, *in vacuo*, at the level of the sea, and at 68° of Fahrenheit. As the same pendulum, when brought back to London, in 1823, made 86236,95 vibrations, it follows, that the length of the seconds pendulum at San Blas, is 39,03776 inches. By comparing this with Captain Kater's results, Captain Hall finds that the

Mean diminution of gravity from the Pole to the Equator, is	.0054611
Mean Ellipticity, ...	$\frac{1}{313,55}$
Length of equatorial pendulum, . . .	39.00904

From a second set of experiments made by Mr Henry Foster, the numbers were,

Diminution of gravity, ...	.0054095
Length of seconds pendulum, . . .	39.03881
Mean ellipticity, ...	$\frac{1}{308.56}$

These observations, however, were made under circumstances less favourable than those of Captain Hall.

Rio de Janeiro, where the third set of observations was made, is situated on the coast of Brazil. The station was on granite, 72 feet above the sea, and in West Longitude 43°, and South Latitude 22° 55′ 22″. The pendulum performed 86131,70 vibrations in a mean solar day, *in vacuo*, at the level of the sea, and at 60° of Fahrenheit. Hence Captain Hall finds that

The length of the seconds pendulum at Rio de Janeiro is,	39,04381
Diminution of gravity from the Pole to the Equator, .	.0053365
Mean Ellipticity, ...	$\frac{1}{301,77}$
Length of equatorial pendulum, . .	39,01223

From another set of observations, made at the same place, and with the same pendulum, by Mr Henry Foster, the following results were obtained:

Number of vibrations, . .	86131,55
Length of pendulum, . .	39,04368
Diminution of gravity, . .	.0053431
Mean ellipticity, . . .	$\frac{1}{302,37}$
Length of equatorial pendulum, .	39,01206

Captain Hall considers these results as more entitled to credit than his own, as the temperature was more steady, and the clock's rate more uniform.

The attentive reader will already have remarked, that the invariable pendulum with which these observations were made, is said to have performed 86235,98 vibrations at London, in 1820; whereas, when it was brought back, in 1823, it performed 86236,95 vibrations, being a difference of 0.97. As this difference could not possibly arise from errors of observation, it becomes highly interesting to discover the cause of it.

"Captain Kater," says Captain Hall, "was disposed to assign it to an accident which had happened to the pendulum at San Blas, but which I, at first, imagined inadequate to such an effect. The accident was this: The pendulum, when not in use, was, as usual, raised by means of a screw, so that the knife-edge was lifted clear of the agate planes on which it vibrated during the experiments. This screw being too small, or having some flaw in it, unexpectedly broke at San Blas, before the experiments there were begun; and although the knife-edge was not raised more than the twentieth of an inch, yet, as the pendulum weighed more than 15 lb., the fall might, he thought, have altered the form of so delicate an edge in a slight degree, and thus have virtually lessened the distance between the point of suspension and the centre of oscillation *.

* "If the knife-edge be supposed to have become cylindrical, the virtual point of suspension, it has been demonstrated, would be at the distance of the radius of curvature of this cylindrical portion below its surface, and the number of vibrations of course be greater than before."

"As the whole pendulum had acquired a coating of oxide, with the exception of the tail-piece, which was lackered, I was desirous of ascertaining in what manner and to what degree its vibrations would be effected by this partial addition of weight; and, for this purpose, the following experiments were made. The vibrations of the pendulum, in its oxydized state, having been determined, 10 grains of weight were affixed at two-thirds of the length of the bar (measured through the ball) from the point of support, that being supposed to be near the centre of oscillation of the oxide. This had for its object to discover, before cleaning the pendulum, what would be the effect of an addition of weight at that place. On swinging it, accordingly, the number of vibrations was increased 0,83 in 24 hours. It was then taken to the Mint, and the weight, carefully determined by Mr Barton, in one of his delicate balances, was found to be 15 lb. 10 oz. 14 dwt. 12½ grains. It was next cleaned by Captain Kater, by means of diluted sulphuric acid, and afterwards washed with a solution of soda in water; and, being effectually dried, was again weighed, when it was found to have lost exactly 24¾ grains. Coincidences were now taken on three succeeding days, and the number of vibrations of the pendulum, in its clean state, proved to be fewer than when it was coated with oxide, by only 0,73 of a vibration. Since no more than one-fifth part of the oxide removed could be oxygen, only one-fifth of the above difference between its vibrations when clean and when coated, or 0,14, can be ascribed to additional weight, since it was formerly swung in 1820; the real difference, however, to be accounted for being 0,97, this cause is manifestly inadequate to the effect. I have therefore thought it right, after attentively considering every other possible manner in which the pendulum could have been altered, to adopt the idea which had been suggested, and which was eventually proved to be correct, since the knife-edge, upon removal after the experiments were over, was found to be distinctly rounded. To obtain the most correct results, I have accordingly used the vibrations made in London, in 1820, to compare with the experiments made before the accident, and the vibrations recently determined in London, for comparing with those made after it,—an arrangement rendering the resulting ellipticities entirely independent of that circumstance."

We cannot avoid regretting, along with Captain Hall, that he was obliged to leave the neighbourhood of the Equator without making more numerous observations. It would have been highly desirable, as he states, to have swung the same pendulum at stations remote from the Galapagos, but resembling them in insular situation, in size, and in geological character, such as the Azores, the Canaries, St Helena, the Isle of France, and various stations among the eastern islands of the Indian and Pacific Ocean, and we hope still to see this accomplished.

It is scarcely necessary to remind our readers, how much this branch of science owes to the talents of Captain Kater, who invented the apparatus itself, and first pointed out the methods of using it. It has since been employed by Captain Sabine, at Melville Island, on the coast of Africa, and on the shores of Lapland and Norway; while it has been used, with equal success, by Mr Goldingham, at Madras, by Sir Thomas Brisbane, in New Holland, and by Captain Hall, on the coast of the Pacific. Captain Hall has, with much propriety, addressed the account of his observations to Captain Kater, and has paid him the high compliment of stating, "that, after many trials of fancied improvements, and simplifications of your methods, both in the conduct of the experiment itself, and in the subsequent computations, I was finally obliged to acknowledge, in every instance, even where I succeeded, that I had, by more labour, or by a more circuitous path, reached the same point to which your rules would at once have led me."

ART. XIII.—*Gleanings of Natural History, during a Voyage along the Coast of Scotland in* 1821. By the Rev. JOHN FLEMING, D. D., F. R. S. E., M. W. S. &c. (Concluded from Vol. IX. p. 254.)

THE Isle of Glass or Scalpa, presents to the sea a broken irregular rocky shore, of no great height or boldness. The surface of the island possesses but little elevation, though it is uneven, and exhibits numerous, narrow, parallel transverse valleys, bounded by nearly perpendicular walls of rock. The prevailing minerals of this island are few in number. Gneiss may be considered as the ordinary rock. It is thick slaty, and includes numerous contemporaneous portions of hornblende rock, dark

mica-slate, granite, and blue and white quartz. At the point, however, at which the light-house is situate, and which still retains its Norwegian appellation *Klibberness*, that is, Soapstone Promontory, several minerals occur, associated with a nearly vertical bed of common serpentine.

The *Serpentine* is of a uniformly dark-green hue. Its weathered surface is nearly even, and of a brownish colour. Its relation to the gneiss, on its west side, is not well displayed; but, on its opposite side, it unites therewith by a series of irregular beds, in which *Chlorite* may be considered as the prevailing ingredient. This substance, in some places, is in the form of nearly unmixed chlorite-slate; while, in others, its appearance is much altered by the quantity of black mica and large imperfect crystals of *Hornblende* which it contains. In one place there is a thick mass of that singular variety of hornblende rock described by Professor Jameson in his "Mineralogy of the Scottish Isles," Vol II. p. 15., as occurring in Iona. It consists of a green coloured, hard, compact felspar, with numerous crystalline grains of hornblende*. In a vein in this rock, I observed small translucent greyish-coloured crystals of *Augite*, along with quartz and calcareous spar.

In the Serpentine, the following minerals were observed:—
1. *Potstone.* This forms a thick mass, occasionally much mixed with small crystals of magnetic iron-ore, and *Actynolite.* 2. Translucent *Steatite*, in small veins. 3. *Asbestus*, in short irregular veins, from a tenth of an inch to upwards of one inch in thickness. 4. *Common Dolomite*, in the form of a short contemporaneous vein. 5. *Magnetic Iron-ore* abounds in all the minerals with which the Serpentine is connected; and, in that rock itself, it occurs disseminated in such quantity as to alter considerably its fracture and weight. In one place, I observed it collected into a short contemporaneous vein, much mixed with asbestus, and so greatly acted upon by the crystalline force of that mineral, as to exhibit an imperfectly fibrous structure.

When on the eve of our departure from this island, we got on

* The characters of this rock, and indeed of many of the less distinct combinations of hornblende and felspar, are rendered more obvious by heating a portion to redness. The different ingredients become perceptible by a difference in colour, lustre, and structure,

board a live example of the Great Auk (*Alca impennis*), which Mr Maclellan, the tacksman of Glass, had captured some time before, off St Kilda. It was emaciated, and had the appearance of being sickly; but, in the course of a few days, it became sprightly, having been plentifully supplied with fresh fish, and permitted occasionally to sport in the water, with a cord fastened to one of its legs, to prevent escape. Even in this state of restraint, it performed the motions of diving and swimming under water, with a rapidity that set all pursuit from a boat at defiance. A few white feathers were at this time making their appearance on the sides of its neck and throat, which increased considerably during the following week, and left no room to doubt, that, like its congeners, the blackness of the throat feathers of summer is exchanged for white, during the winter season. I may add, that the black colour of the throat of the Razor-bill (*Alca torda*), was at this time undergoing a similar change. In the young of this species the neck was black, but the throat was freckled with white. The bill was black, with the rudiments of a single ridge, and the white line reaching to the eye was obvious. At this time, the Shear-water (*Puffinus Anglorum*) appeared in large flocks.

After leaving the Isle of Glass, and taking shelter, on the 19th of August, in Loch Maddy, we sailed across to Sky, on the 20th, and entered Loch Scavig, where we landed. At the head of this bay, a small rivulet from Loch Coruisk, falls over an irregular ridge of rock into the sea. Numerous trouts and salmon were collected near its mouth, and occasionally attempted to make their way up the stream. The great drought of the season, however, had so much diminished the quantity of water, at this time, as to render their efforts ineffectual.

Glen-Coruisk is no less remarkable for the matchless sterility of the precipitous cliffs and pointed summits of the mountains, by which it is enclosed, than for the characteristic displays of the strata of hypersthene, of which these consist. This mineral occurs massive, and imbedded in small prismatic concretions in common and glassy felspar.

Upon our departure from Loch Scavig, we visited the deservedly celebrated spar-cave of Strathaird, sometimes termed,

in honour of the proprietor, *Macalister's Cave.* It occupies a fissure in the sandstone, which had formerly been filled with basalt. This original condition may be readily inferred from the appearances which present themselves in the floor, at the entrance, and near low water-mark, where a portion of the sandstone yet appears enclosed by the trap, and where the walls of the vein are entire. The interior of the cave exhibits, in great beauty, the various forms which the calcareous stalactites and stalagmites assume, and displays the carbonate of lime, in all the stages of its crystallization.

On the morning of the 21st, we were abreast of the Island of Egg; and, shortly after, landed at the well known cave in which the Macdonalds of this isle, who had taken shelter in its recesses, were suffocated with smoke, by their enemies the Macleods, in the days of clanship, ignorance, ferocity, and revenge. On the beach, a few examples of the *Lepas fascicularis* of Ellis were observed, attached to the remains of the spawn from which they had sprung. This substance still adhered to the quill-feathers of gulls, which appeared to be but little altered by maceration. Subsequently, I have found the young of the *Balanus balanoides* upwards of a tenth of an inch in diameter at the base, and seated on the eggs of the *Buccinum undatum.* These facts lead to the conclusion, that rapidity of growth is a distinguishing feature both of the pedunculated and the sessile cirrhipedes.

The rocks in the neighbourhood of the cave, consist of various beds of amygdaloid and greenstone, containing, in their cavities, radiated and capillary *Mesotype,* and transparent crystals of *Cubizite.* One of the beds of greenstone appeared of a singular character, in having a basis of glassy felspar, and containing, along with the hornblende, numerous dispersed grains of magnetic iron-ore. The two remarkable *Pitchstone* veins in the neighbourhood, were likewise hastily inspected. The pitchstone in these veins is highly bituminous.

The Sciur of Egg, which we now ascended, is a very remarkable hill, on account of the steepness of its sides, and the thick bed of columnar pitchstone-porphyry which forms its summit. The basis of this porphyry is considered as intermediate between pitchstone and basalt. In one place, it seemed to pass into heliotrope. It contains crystals of glassy *felspar;* and occa-

sionally nodules of *chalcedony* and conchoidal *hornstone*, were observed. In the fissures of the rocks, the beautiful *Cyathea fragilis* was abundant. The temperature of a spring, evidently perennial, on the south-eastern base of the hill, was 47° Fahr.

In the forenoon of the 22d, we reached the far-famed Staffa, and were peculiarly fortunate in having it in our power to enter Fingal's Cave, in a boat, without being much incommoded by the swell of the sea. The shores of this island exhibit well marked sections of the beds of amygdaloid and basalt, of which it consists, and offer no obstacle to an examination of the forms, structure, and bendings of its interesting columns. On the soil, the *Orobanche rubra* was observed in plenty, but in fruit; and an abundant supply of the eatable mushroom was procured.

In the afternoon of the same day, we visited the ruins of Iona. I had time to glance only at the strata of clay-slate near the landing-place, at the ruins, and to break off a specimen from the red granite blocks which were in the neighbourhood. This last, however, was not without interest, as it contained, besides a few scattered crystals of hornblende, numerous depressed doubly oblique prisms of *Sphene*.

The weather was unfavourable during the whole of the 23d. On the 24th, we touched at Isla, landing at Portnahaven; and, on the morning of the 25th, we found ourselves a-breast of the Giant's Causeway. The basaltic scenery here, though superior to that of Staffa in height and breadth, and the patches of rich green pasture with which the dark ground is relieved, is yet destitute of that distinctness which adds so much to the elegance of Fingal's Cave. At the Causeway, the accumulations of debris conceal much that would interest. At Staffa, every thing is exposed, the sea washing away the disintegrated portions as speedily as they are produced. The rocks, however, are the same at both places, being basalt and amygdaloid; but here the latter is more varied in its contents, and the whole mass of trap rests on chalk. Upon landing at the Causeway we were soon joined by a host of natives, exhibiting, in their tattered dress, flattering appellations, and impetuous manner, their peculiar marks. Each vied with his neighbour in praising his own qualifications as a guide. Specimens collected from the neighbouring cliffs, and contained in small boxes of rude workmanship,

were eagerly offered for sale. Among these, we picked out the following minerals. 1. *Calcareous Spar*, of a brownish colour. 2. *Cubizite*, transparent, and regularly crystallized; and, when occurring in the same cavity with the preceding, usually occupying the place nearest the walls. 3. A mineral resembling *Thomsonite*, but not yet sufficiently examined. Only two small specimens of this mineral were observed, though eagerly sought after. Hence it is probably of rare occurrence. These had formed a coating on the interior of a cavity in the amygdaloid, and exhibited perfect crystals shooting from the base. 4. *Arragonite*. This occurs massive, of a white, grey, or pale-green colour, and scopiformly narrow radiated structure. Even where much mixed with the rock, it still appears capable of exercising that influence which produces its radiated appearance.

Leaving the Causeway, we bent our course towards Portrush, where we again joined the vessel, visiting, in our progress, the extensive quarries of chalk, and glancing at the amygdaloid, with its incumbent augite-greenstone in the neighbourhood of the harbour.

On the 26th, we landed at the light-house situate at the west side of the Mull of Cantyre. The strata in the immediate neighbourhood, are of mica-slate, stretching in a south-westerly direction, and dipping eastward. The slate is thick slaty, and consists of a basis of grey quartz and silvery mica, with oblong, opake and translucent concretions of quartz. The same kind of mica-slate likewise prevails to the north of the town of Campbeltown, and occupying a similar position. At the latter place, however, it in general contains more mica, and is thin slaty, and characteristically waved. Eastward from a quarry, near the town, of this mica-slate, and in conformable position, and even interstratified therewith, are numerous beds of sandstone and trap conglomerate, foliated limestone, red slate-clay, and red sandstone. Near the extremity of the north side of the bay, these beds are covered with greenstone and amygdaloid, and a coarse clayey basalt. The latter rock is, in some places, columnar; but the columns, which are vertical, are frequently separated several inches from one another, the interval being filled up with ferruginous clay, green earth, calcareous-spar, or a substance resembling sandstone. Compact and hematitic red iron-

stone abounds in these spaces, and in numerous veins with which the rock is traversed. On the south side of Campbeltown Bay, the same series of slaty rocks occurs, with the addition of a thick bed of reddish compact felspar-porphyry. The most interesting beds in the whole of this series are the Limestones. These are of two kinds; both, however, granularly foliated, (and, as far as was observed) destitute of organic remains. The first is common, small granular limestone, of a reddish colour, in the form of thin beds in the sandstone. The second constitutes the mineral termed *Foliated* or *Sparry Lucullite.* It is of a velvet black colour, and appears in the form of angulo-granular portions, from a quarter to half an inch in size. These may be regarded as imperfect rhomboidal crystals. They are closely united by white, fine granular limestone. The stone is extensively quarried and burnt for lime, on the north side of the bay. The strata are somewhat irregular. The surfaces of each present protuberances indicative of the concretions; or, in consequence of the cementing matter being raised, a singularly reticulated aspect is exhibited. The fracture of the concretion is usually slightly curved foliated; but, in some cases, the fracture is straight foliated, and the angles of the rhomb have the same value as calcareous spar. The black colour of the concretions arises from the intimate mixture of charcoal. This is easily manifested in their solution in acids, by the black powder which remains. By what power, it may be asked, has the charcoal been separated from the cement, and incorporated exclusively in the concretions? The charcoal seems mechanically mixed; and hence probably gives the curvature to the planes of the spar, in the concretions. The dark colour and foliated fracture of the concretions, contrasted with the white colour and fine granular fracture of the connecting matter, render this rock, in hand specimens, one of the most beautiful minerals of which Scotland can boast.

On the morning of the 30th, I took leave of my kind and attentive friend, and embarked on board the Britannia steam-packet for Glasgow.

Art. XIV.—*Observations on Double Stars.* By M. Struve of Dorpat. (Continued from Vol. IX. p. 341.)

The very interesting observations of M. Struve of Dorpat, which we laid before our readers in the last Number of this Journal, we are now able to continue, from the *Correspondance Astronomique* of Baron Zach, who has extracted them from the second volume of M. Struve's Collection of Astronomical Observations. The same class of observations is continued in the 3d volume of the same Recueil, so that we shall have occasion to resume the subject in a future Number.

17. *α Cassiopeia.* R. Asc. 0^h 30′. Decl. 55° 33′ N.
2d–3d and 9th–10th Magnitudes.

As the small star changes both its distance and its angle of position, it must describe an ellipse round the great one. The following are the observations:

	Distances.	Angle of Position.	Diff. in R. Asc.	Diff. in Decl.	
1780.7,	52″.81	41° 0′	—1′10″.0	+ 34″.6	*Herschel.*
1815.2,	59 .40	10 33	—4 13 .2	+ 10 .9	*Struve.*
1819.9,	58 .80	9 3	—1 42 .6	+ 9 ·25	*Ditto.*

18. *Cassiopeia* 78. R. Asc. 0^h 38′. Decl. 50° 27′ N.
Stars of variable Magnitudes.

According to Sir W. Herschel, these stars were in 1780 of very unequal magnitude, and difficult to be seen. M. Struve sees them at present with difficulty, and their magnitude is nearly equal, viz. 7.8. The distance is supposed to increase.

1780.7,	Angle of Position	50° 30′ S. Foll.	*Herschel.*
1819.6,	- -	58 42	*Struve.*

19. 65 *Pisces.* R. Asc. 0^h 40′. Decl. 26° 43′ N.
6th–7th and 6th Mag.

Difference of R. Asc.	-	—0″.384
Angle of Position,	-	26°.85 N. Prec.
Distance,	- -	5″.77 calculated.
Difference of Declin.	-	+ 2″.60 ditto.

Sir W. Herschel found the angle of position 30° 57′ N. Prec

20. *Pole Star.* R. Asc. 0h 56′. Decl. 88° 21′ N.
2d and 11th Mag.

M. Struve has found for the effect of parallax —0″.32, but in the opposite direction to which it ought to be. The constant of aberration was 20″.112, whereas he found it 20″.300 by other stars. Baron Zach found it, from Bradley's observations, to be 20″.232; Bradley made it 20.″25, Delambre 20.″255, and later astronomers 20″.36. The following are M. Struve's observations:

	Diff. of R. Asc. in Time.	Angle of Position.	Distance.	Diff. of Decl.
1815,	— 21″.04	60° 16	18″.50	— 16″.10
1819,	— 20 .53	60 25	18 .05	— 15 .70

21. *γ Aries.* R. Asc. 1h 44′. Decl. 18° 55′ N.
4th and 4th Mag.

Angle of Position in 1779.8 was	84° 0′		*Herschel.*
1780.8,	86	5	*Ditto.*
1802.2,	89	10	*Ditto.*
1819.8,	84	3	*Struve.*

M. Struve considers that the differences are attributable to errors of observation, and not to any motion in the stars.

22. *α Pisces.* R. Asc. 1h 53′. Decl. 1° 53′ N.
3d–4th and 5th–6th Mag.

Angle of Position in 1781.8, was	67° 23′		*Herschel.*
1802.1,	63	0	*Ditto.*
1819.9,	70	48	*Struve.*

M. Struve thinks that none of the stars move.

23. *γ Andromeda.* R. Asc. 1h 53′. Decl. 41° 28′ N.
3d and 5th Mag.

The *largest* of these two fine stars is *yellow*, and the *smallest blue.*

Angle of Position in 1781.8, was	19° 37′		*Herschel.*
1802.1,	26	34	*Ditto.*
1803.1,	26	5	*Ditto.*
1804.1,	27	39	*Ditto.*
1819.9,	25	35	*Struve.*
Diff. of R. Asc. in 1819.9,	+ 0″.837		*Ditto.*
Distance calculated, -	10 .48		*Ditto.*
Diff. of Declin. ditto, -	+ 4 .52		*Ditto.*

24. Variable star in the *Whale*, R. Asc. 2^h 10′. Decl. 3° 48′ S.

The greatest star is variable, and of a decided red colour at its greatest lustre. Its very small companion follows it a little to the north.

Angle of Position in 1819,	1° 24′ N. Foll.	*Struve.*
Diff. in R. Asc.	+ 7″.682	*Ditto.*
Distance, -	1′ 54″.25	*Ditto.*
Diff. of Declin.	+ 2 .79	*Ditto.*
Distance, -	{1 44 .2 / 1 53 .0}	*Herschel.*

25. 30 *Arietis*. R. Asc. 2^h 27′. Decl. 23° 52′ N. 6th–7th and 7th Mag.

1819, Diff. of R. Asc.	— 2″.766	*Struve.*
Distance,	38 .26	*Ditto.*
1780, Distance,	31 .1	*Herschel.*

26. η *Perseus*. R. Asc. 2^h 38′. Decl. 55″ 8, N. 4th and 8th Mag.

Angle of position in	1779,	20° N. Prec.	*Herschel.*
- -	1819,	29° 9′	*Struve.*
Distance,	1779,	26″	*Herschel.*
- -	1819,	28″.5	*Struve.*
Difference of Decl.	——	+ 14″.2	*Ditto.*

27. θ *Orion*. R. Asc. 5^h 26′. Decl. 5° 32′ S.

This is a group of five stars forming a trapezium, and enveloped in a nebulosity. The first star (in R. Asc.) is of the 7th Mag., the 2d of the 8th Mag., the 3d of the 5th Mag., and the 4th of the 6th–7th Mag. M. Struve found the angles of position to be as follows, in 1819:

3d and 4th.	1st and 3d.	1st and 2d.	2d and 4th.	2d and 3d.
29° 45′ N. Foll.	45° 9′ N. Prec.	58° 8′ N. Foll.	31° 0′ N. Prec.	74° 0 N. Prec.

28. σ *Orion*. R. Asc. 5^h 30′. Decl. 2° 43′ S.

A triple star. The 1st is of the 4th Mag., the 2d of the 7th Mag., and the 3d of the 7th Mag. In 1819,

	1st and 2d.	1st and 3d.
The angle of position was	6° 5′ N. Foll.	28° 35′ N. Foll.
Difference of R. Asc.	+ 0″.90	+ 2″.442

Sir W. Herschel found the angles of position 5° N. *F*, and 29° N. *P.*, and the distance between the 1st and 3d 43″.2.

29. 38. *Gemini.* R. Asc. 6^h 44′. Decl. 13° 24′ N.
5th and 8th Mag.

The small star follows the other a little to the east, at the distance of + 0″.09, and is farthest south.

Angle of position in	1782 was,	89° 54′	S. Foll.	*Herschel.*
	1802,	86 6	S. Prec.	*Ditto.*
	1820,	86 3	S. Foll.	*Struve.*

30. δ *Gemini.* R. Asc. 7^h 9′. Decl. 22° 18′ N.
3d and 9th–10th Mag.

The angle of position is very difficult to measure, on account of the smallness of the little star.

Angle of position in	1781.9, was,	85° 51′	*Herschel.*
	1802.1,	76 21 / 73 5	*Ditto.*
	1804.1,	69 52	*Ditto.*
	1820.0,	79 39	*Struve.*

31. 31. *Canis Minor.* R. Asc. 7^h 31′. Decl. 5° 43′ N.

This star, which is the 307th of Mayer's Catalogue, is very fine and difficult to distinguish.

Angle of position in 1781 was,	27° 5′	S. Foll.	*Herschel.*
April 1820,	38 25	N. Prec.	*Struve.*

32. ζ *Cancer.* R. Asc. 8^h 2′. Decl. 18° 11′ N.
5th and 6th–7th Mag.

Angle of position in	1781.9,	88 [illegible]6′	S. Prec.	*Herschel.*
	1802.1,	81 47	S. Foll.	*Ditto.*
	1820.3,	71 21		*Struve.*
Diff. of R. Asc.	1819,	+ 0″.12		

33. 1. υ *Cancer.* R. Asc. 8^h 16′, Decl. 25° 7′ N.
6th and 7th Mag.

Angle of position in	1782.1,	32° 9′	N. Foll.	*Herschel.*
	1820.3,	55 24		*Struve.*

34. 2. σ *Ursa Major.* R. Asc. 8^h 54′. Decl. 67° 51 N.
5th and 10th Mag.

These two stars are nearly in the same parallel, the smallest being a little to the south.

Angle of position in	1782.5,	13° 0′	N. Prec.	*Herschel.*
	1819,	2 9	S. Prec.	*Struve.*
Diff. of R. Asc.		— 1″.27		
Distance,		7 .19		
Diff. of Decl.		— 0 .36		

35. 38. *Lynx.* R. Asc. 9h 7′. Decl. 37° 34′ N.
5th and 7th–8th Mag.

Angle of position in 1780, was	26°		S. Prec.	*Herschel.*
1820,	32 5′		S. Prec.	*Struve.*
Distance,		5″.08		*Ditto.*
Diff. of R. Asc. in 1819,		— 0 .362		*Ditto.*

36. 40. *Lynx.* R. Asc. 9h 10′. Decl. 35° 9′ N.
3d–4th and 12th Mag.

The small star is very difficult to be seen.

Diff. of R. Asc.	1819.5,	0″.51′	*Struve.*
Diff. of Decl.		1 .47	*Ditto.*
Angle of position,		55° S. Foll. as calculated.	
Ditto.	1782.9,	58 12 N. Prec.	*Herschel.*

37. *h Ursa Major.* R. Asc. 9h 17′. Decl. 63° 51′ N.
3d–4th and 10th Mag.

In 1818 and 1819, M. Struve, found from numerous observations, the difference of R. Asc. to be — 3″.275, and the angle of position 1°.5 N. Prec. Hence the distance is 21″.64, and the difference of Decl. + 0″.56. Sir W. Herschel had found the distance 19″.23, and the angle of position 3° N. Prec.

38. *Cor Caroli.* R. Asc. 12h 47′. Decl. 39° 18′ N.

In 1819, M. Struve found the difference of R. Asc. to be — 1″.18, the angle of position 46° 27′ S. Prec., and consequently the distance 19″.87, and the difference of Decl. 14″ 41. Sir W. Herschel had found the distance 20″, and the angle of position 42°.

39. *ζ Ursa Major.* R. Asc. 13h 17′. Decl. 55° 52′ N.

These stars are very remarkable, in so far as both of them have a proper motion. In 1814 and 1815 M. Struve had found the difference of R. Asc. to be 40″.96, the angle of position 58° 7′, and consequently the distance 15″.25, and the difference of Decl. — 13″.0. In 1819, he found the difference of R. Asc. + 0″.962, and the angle of position 55° 20′ S. Foll. Hence the distance is 14″.24, and the difference of Decl. + 11″.71. Sir W. Herschel believed, that the angle had dimi-

nished 5° 32, in 21 years, but this seems to be an error from the following calculations.

1755,	Distance,	13″.88	Angle of position,	53° 3′	*Bradley.*
1781.9,		14.50		56 46	*Herschel.*
1800,		15.91		56 1	*Piazzi.*
1802.8,				51 14	*Herschel.*
1819.7,		14′24		55 20	*Struve.*

40. *ι Bootes.* R. Asc. 14h 10′. Decl. 52° 12′ N.
4th–5th, and 9th Mag.

Angle of position in 1779, 53° Foll.		*Herschel.*
Distance, . .	37″.56	*Ditto.*
Angle of position, 1819,	56° 55′ N. Foll.	*Struve.*
Distance, . .	38″.55	*Ditto.*
Difference of declination,	32 .29	*Ditto.*
Diff. of R. Asc. 1817,	+ 2 .29	*Ditto.*

41. *ε Bootes.* R. Asc. 14h 37′. Decl. 27° 51′ N.
3d–4th and 7th Mag.

The *greatest* of these stars is *yellow,* and the *least, blue.*

Angle of position in	1780.7, was	32° 19′ N. Prec.	*Herschel.*
	1802.2,	44 52 ditto,	*Ditto.*
Observed, .	1819,	51 7 ditto,	*Struve.*
Diff. of R. Asc. . .		— 0″.232	*Ditto.*
Diff. of declin. . .		1 .5	
Angle of position deduced, .		56° 5	

42. *ξ Bootes.* R. Asc. 14h 43′. Decl. 19° 51′ N.
5th and 7th Mag.

Angle of position in	1782.3,	65° 53′ N. Preced.	*Herschel.*
	1792.2,	94 16	*Ditto.*
	1795.2,	95 4	*Ditto.*
	1802.3,	96 34	*Struve.*
	1819.6,	105 0	*Ditto.*
Diff. of R. Asc.		—′ 0″ 102	

43. 39 *Bootes.* R. Asc. 14h 43′. Decl. 49° 27′ N.
6th–7th and 8th–9th Mag.

Sir W. Herschel observed the angle of position to be 38° 21′ N. Foll. in 1783.5, and in 1819, Struve found it to be 49° 33′ N. Foll. The difference of R. Asc. was + 0″.332, in 1819, and hence the distance was 5″.

44. *δ Serpent.* R. Asc. 15h 26′. Decl. 11° 9′ N.

3d–4th Mag. and 5th–6th Mag.

The distance of these stars is supposed to increase.

Angle of position in	1782.7,	42° 48′ S. Preced.	*Herschel.*
	1802.1,	61 27	*Ditto.*
	1819.7,	67 41	*Struve.*

45. ζ *Crown.* R. Asc. 15^h 33′. Decl. 37° 11′ N.

4th–5th and 6th Mag.

Angle of position, in 1779,	26°	N. Preced.	*Herschel.*
Distance, . .	4″.7		*Ditto.*
Angle of position, 1819,	29° 9′		*Struve.*
Distance, . .	7″.25		*Ditto.*

46. ξ *Balance.* R. Asc. 15^h 54′. Decl. 10° 52′ S.

4th and 7th Mag.

These stars appear to have undergone great changes, both in distance and in the angle of position. The great star appeared oblong both to Herschel and Struve; so that it may be expected to separate into two.

Angle of position in	1780.4,	1° N. Foll.	*Herschel.*
Ditto calculated,	1819,	21°	*Struve.*
Distance, .	1780.4,	6″. 4	*Herschel.*
	1819,	9 .31	
Diff. of R. Asc.	.	+ 0 .59	
Diff. of Decl.	.	0 .38	

47. 49 *Serpent.* R. Asc. 16^h 4′. Decl. 14° 1′ N.

7th–8th and 7th Mag.

M. Struve has been able to observe this star only twice, on account of the difficulty of seeing it.

Angle of position in	1783.3,	21° 33′	*Herschel.*
	1803.4,	32 52	*Ditto.*
	1804.3,	35 10	*Ditto.*
	1820.1,	46 3 N. Prec.	*Struve.*
Diff. of R. Asc.	.	0″.13	*Ditto.*
Diff. of decl. estimated,		1 1	*Ditto.*

48. γ *Hercules.* R. Asc. 16^h 14′. Decl. 19° 35 N′.

3d Mag. and the other very obscure.

This star is so difficult to see, that M. Struve only observed it once on the 3d June 1819.

Angle of position	1781,	19° S. Prec.	*Herschel.*
	1819,	26° 8′	*Struve.*
Distance observed,	1781,	41″.8	*Herschel.*
Ditto calculated,	1819,	40 .8	*Struve.*
Diff. of R. Asc.		2 .58	*Ditto.*

49. 17 *Dragon.* R. Asc. 16^h 32′. Decl. 53° 17′ N.
5th and 6th Mag.

Sir W. Herschel found the angle of position to be 24° S. Foll.; and, in 1819, Struve found it 26° 10′. The difference of right ascension was + 0″ 419; the difference of declination, 1″ 85; and the distance 4″·19.

50. 43 *Hercules.* R. Asc. 16^h 37′. Decl. 8° 55′ N.
4th–5th, and 9th–10th Mag.

Sir W. Herschel says that these stars are nearly of equal magnitude, and that the distance is about 12″. M. Struve found, in 1819, that the difference of right ascension was —4″ 15; the angle of position 39° 7′ S. preced.; whence the distance is 1′ 23″.7, and the difference of declination, — 53″.5. If Sir W. Herschel observed the same star that Struve did, one of them must be variable, and their motion prodigiously great.

51. 46 *Hercules.* R. Asc. 16^h 38′. Decl. 28° 42′ N.
6th–7th and 11th Mag.

Angle of position in	1783.1,	66° 36′ S. Foll.	*Herschel.*
	1802.7,	76 18	*Ditto.*
	1819.7,	81 12	*Struve.*

(*To be continued.*)

ART. XV.—*Observations on a new Natural Family of Plants, to be called Cobeaceæ**. By Mr DAVID DON, Assistant-Secretary to the Linnean Society, Corresponding Member of the Wernerian Natural History Society, &c.

IT not unfrequently happens that the most common plants are those which are the least understood, in a botanical point of view. The objects which have already become familiarized to our eyes seldom attract our attention, and the weeds which we trample under foot are heedlessly passed over as unworthy of our examination. These remarks are applicable to a great many of our most common plants, and to one of those, which I am about to describe, namely, *Cobæa scandens*, which adorns our garden-

* Read before the Wernerian Natural History Society, 26th April 1823.

walls and arbours with its twining leafy branches and profusion of large blossoms. This graceful plant is a native of the Great Valley of Tenochtitlan, near the city of Mexico, and was first introduced into Europe in the year 1787, and, from its ready propagation, both by cuttings and seeds, has now become almost as common in our gardens as the ivy. The genus *Cobæa* was first described by the Abbé Cavanilles, in the first volume of his excellent work, entitled *Icones Plantarum.* Cavanilles has referred it to the *Bignoniaceæ*, and this arrangement has been followed by the greater part of botanists. A slight examination, however, will shew clearly that this view of the affinity of *Cobæa* is extremely erroneous, and that its true place in the natural system has hitherto been entirely overlooked. The Genus, indeed, possesses almost no character in common with the Order in which it has had the misfortune to be placed by botanists. In order, however, to shew this more clearly, it will be necessary to state the great differences which exist between them. *Cobæa* is distinguished from the *Bignoniaceæ* by a regular pentandrous corolla, by its long, simple, undivided, incumbent anthers, by a triple stigma, by the structure and form of its fruit, and by its nearly erect seeds, furnished with a fleshy albumen, and a simple covering. These characters bring it very near to the *Polemoniaceæ*, to which, of all established orders, it bears the strongest affinity, as M. Desfontaines has already suggested *; but it is abundantly distinct from these also, by the valves of the capsule being naked, and not septiform, by the oblique position of the seeds, and by the habit of the plant itself. I therefore propose to form a distinct Order, to which the name of *Cobeaceæ* may be given. *Cobæa*, the only known genus referable to it, has hitherto consisted of only a solitary species; but the extensive Herbarium of Aylmer Bourke Lambert, Esq., has enabled me to enrich it with a second species, collected by Don Juan Tafalla, a pupil of Ruiz, in the province of Quito, in Peru; and it is to be hoped that many new genera and species belonging to this Order still remain to be discovered in the extensive and little known regions of South America.

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* Ann. Mus. 2. p. 30.

COBEACEÆ.

Bignoniac. pars, *Juss. et Auctor.*

Calyx foliaceus, 5-fidus, æqualis.

Corolla campanulata, limbo 5-loba, æqualis, æstivans imbricata.

Stamina 5, fertilia, æqualia, exserta, basi cum corollæ tubo connata. *Antheræ* indivisæ, compressæ, biloculares, per medium filamentis incumbenti-adnatæ.

Ovarium simplex, triloculare: *ovulis* pluribus, adscendentibus. *Stylus* simplex. *Stigma* trifidum.

Capsula cucurbitacea, trilocularis, trivalvis: *valvis* crassissimis, intùs nudis. *Septa* nulla. *Placenta* maxima, centralis, trigona.

Semina plana, margine alata, duplici serie imbricata: *testa* simplex, superficie mucilaginosa: *albumen* carnosum.

Embryo rectus, foliaceus, incumbens: *cotyledones* cordatæ, integræ: *radicula* infera, recta, centrifuga.

Frutices *scandentes*. Folia *alterna, pinnata, apice cirrhifera.* Flores *axillares, solitarii.*

Obs. Genus Cobææ adhùc Bignoniaceis malè associatum, nunc in novum ordinem constituere necessarium mihi videtur, quòd cum nullâ familiâ usque in serie naturali cognitâ, et minimè omnium cum Bignoniaceis convenit. Ab his longè discrepat corollâ regulari pentandrâ, antheris indivisis incumbentibus, stigmate triplici, frûctus formâ et structurâ, septis nullis, placentâ maximâ trigonâ, seminibus suberectis, testâ simplici mucilaginosâ, albuminis præsentiâ, cotyledonibus integris, radiculâ multò longiore; sed à Polemoniaceis, cui in multis accedit, tantùm triplici charactere, scilicet: seminibus adscendentibus, valvis capsulæ intùs nudis, septis nullis.

COBÆA, *Cavan. Juss.*

Calyx maximus, foliaceus, quinquefidus, præfloratione quinquangulus: *laciniis* latis cordato-subrotundis lanceolatisve, marginibus inter se per paria arctè applicatis, hìnc calyx 5-alatus. *Corolla* ampla, campanulata, limbo 5-loba, æqualis *lobis* latè rotundatis margine tomento tenui vestitis; æstivantibus imbricatis, intùs prope basin coarctata atque lanâ molli niveâ copiosâ instructa. *Stamina* 5, æqualia, omnia fertilia, exserta: *filamenta* crassiuscula, teretia, apice attenuata, basi cum tubo corollæ connata, sed ferè totâ parte libera, erecta, distantia, nisi ad bases, omninò glabra: *antheræ* magnæ, oblongæ, compressæ, indivisæ, biloculares, per medium filamentis incumbenti-adnatæ, apice obtusæ, basi latiore emarginatâ: *loculi* lineares, paralleli, singuli extùs rimâ longitudinali bivalvi dehiscentes et pollen granulosum aureum effundentes. *Ovarium* oblongum, trigonum, basi disco magno nectarifero 5-angulo foveis 5 notato carnoso cinctum. *Stylus* rectus, staminibus brevior, trisulcus. *Stigma* trifidum: *laciniis* linearibus, acutis, æqualibus, intùs planis. *Capsula* pyriformis, cucurbitacea, fructui *Passifloræ* specierum quarundam omninò similis, trilocularis, trivalvis, sulcis 3 angulis placentæ oppositis exarata: *loculis* oligospermis: *valvis* crassissimis, carnosis, marginibus appositis, medio intùs nudis, ovali-oblongis. *Placenta* maxima, trigona, centrali-

sed fructum omninò implens, carnosa, succulenta. *Septa* nulla nisi vestigia ferè obliterata, et in angulis placentæ immersa. *Semina* latissima, compresso-plana, margine alata, duplici serie imbricata, adscendentia: *testa* simplex, tenera, crassiuscula, superficie densè mucilaginosa, lateris interioris prope basin hylo lineari-oblongo notata: *albumen* parcum, carnosum, lacteum, molle. *Embryo* magnus, rectus, incumbens, lacteus: *cotyledones* latæ, cordatæ, obtusæ, integræ, compressæ, applicatæ: *radicula* cylindracea, crassiuscula, cotyledonibus triplò brevior, infera, recta, basi obtusissima.

Frutices (*Mexicani v. Peruviani*) *diffusi, ramosissimi, scandentes, glabri, frondosi,* Passifloræ *habitu similes.* Folia *tripari-pinnata, alterna, sessilia, apice terminata cirrho valido in spiram convoluto triplici v. quinque ordine dichotomo:* foliolis *integerrimis petiolulatis; infimis stipulas mentientibus.* Flores *magni, axillares, solitarii, pedunculati pedunculus medio bracteis 2 oppositis parvis impari-pinnatis præditus, sordidè purpurei fasciis albis notati aut lutei.*

1. *C. scandens*, segmentis calycinis latè cordato-subrotundis, foliolis ellipticis mucronulatis.

Cobæa scandens, *Cavan. Icon.* 1. p. 11. t. 16. et 17. etiamque Vol. 5. p. 69. t. 500. *Persoon Synop.* 1. p. 185. *Lam. Encyl. Suppl.* 2. p. 305. *Kunth in Nov. Gen. et Sp. Pl.* 3. p. 151.

Hab. in Convalli Tenochitlensi prope urbem Mexico et ad Portum Acapulco Mexicanorum. ♄ ◡. Vulgò dicitur *Yedra Morada*, id est, Hedera violacea.

2. *C. lutea*, segmentis calycinis lineari-lanceolatis mucronatis, foliolis oblongis acutis.

Cobæa macrostema, *Pavon. MSS.*

Hab. ad Portum Guayaquil in Regno Vuitensi Peruvianorum. *Joannes Tafalla.* ♄ ◡. (v. s. in Herb. Pavon. nunc in Mus. Lamb.) Præcedenti similis. *Corolla* lutea, minor. *Stamina* ultra limbum longè exserta. *Stigmata* longiora et angustiora.

Obs. Nomen specificum Pavonii mutavi, quòd genere diverso minùs rectè cum regulis constitutis congruit *.

Art. XVI.—*Observations on the Low Temperature of particular Caverns* †.

In endeavouring to account for the great cold which has been observed in particular caverns, an explanation of this singular fact must be sought for, rather in local peculiarities than in relations of a more general nature. A phenomenon noticed by Professor Pictet, in the neighbourhood of one of those caves ‡,

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* In addition to my observations on the genus *Jacaranda*, (see this Journal, Vol. IX. p. 264.), I beg to add, that Mr Brown appears clearly to have been the first who has noticed the singular formation of the anthers in that genus.

† These ingenious observations are taken by permission from the article Physical Geography in the *Edinburgh Encyclopædia*, which is on the eve of publication. They are necessary to complete the view of this interesting subject, which is given in this Journal, vol. viii. p. 1. 16.—Ed.

‡ See this Journal, vol. viii. p. 8.—Ed.

is calculated to throw some light on the subject, though we are by no means disposed to admit that the conclusion he has drawn from it is altogether free from objection. At the ice-cave of Brezon, in the Alps, a current of cold air was observed to issue, with considerable force, from several crevices near the cavern, which depressed a thermometer exposed to its influence from 51° to $38\frac{1}{2}$°. In applying this fact to the solution of the cause of the phenomenon in question, M. Pictet cites the observations of Saussure on the air rushing from the cavities of Monte Testacco, near Rome; where a little hill, composed of the fragments of urns, and other vases of earthen ware, produces an effect similar to that of the calcareous sides of these icy caverns. Round the base of this artificial mound several caves have been dug, in the back walls of which a number of perforations have been formed, running upwards like chimneys, and through which a current of cold air constantly descends in summer. On the 1st of July 1773, the external air being at 78°.1 Fahrenheit, the thermometer stood at $44\frac{3}{4}$° in one of the caverns, and at 44° in another. "It is certainly a very singular phenomenon," says Saussure, "that, in the middle of the Compagna of Rome, where the air is always burning-hot and suffocating, there should be found a little insulated hill, from the base of which should issue, on all sides, currents of air of an extreme coolness." Saussure mentions several other places, where he observed that a current of air rushing from crevices in the rocks, which formed the sides of caves, was accompanied with a great degree of cold. The caverns in which the cold was the most remarkable, were generally situated in calcareous rocks, at the foot of a mountain. In short, these grottoes appear, in many instances, to be the mouths of natural galleries, communicating with upright shafts, through which a stream of air flows downward, when the temperature of the external air exceeds that of the cavern. The current of air thus determined, must acquire, during its descent, the temperature of the vertical portion of the crevices through which it passes; and that temperature must in general be at least as low as the mean temperature of the place. Professor Pictet supposes that the air descending through these fissures in the strata must be still further cooled by the refrigerating effect of evaporation from the moistened materials which it encounters in its progress;

but that process, though capable of producing in certain circumstances a great diminution of temperature, can contribute, in our opinion, very little to the effect under consideration. Air completely charged with humidity, at the temperature of 44° for example, the temperature of one of the caves of Monte Testaceo must have possessed an extraordinary degree of dryness, at the temperature of 78°, before it entered the vertical perforations which conducted it to the caves, to allow it to be cooled at all by evaporation; and if we assume, that, when it reached the cave, it had not been brought to a state of perfect dampness, this supposition would involve us in greater difficulties, as it would imply that the external air was in a state of dryness, which can rarely occur at Rome. At the temperature of 44°, a cubic inch of air is capable of holding, in the vaporous condition, .002032 grains of water, and at the temperature of 78°, no less than .005878 grains; so that air, at the temperature of 78°, charged with the quantity of water it could hold in solution at 48°, would possess a relative humidity, represented by $\frac{2032}{5878}$ or .346, which would correspond to 23° of De Luc's hygrometer,—a degree of dryness which is seldom observed, except in high latitudes. It would seem, therefore, that, to whatever cause the low temperature is owing, which prevails in the caves of Monte Testaceo, and the icy caverns formerly described, no part of the effect can be ascribed to evaporation. On the contrary, we have not the smallest doubt it will be found, by a more particular examination of the state of those caves, that a deposition of moisture takes place from the external air before it reaches the cavern. At the same time, it is difficult to conceive in what other way the air could be reduced to a temperature so low as 44°, in the latitude of Rome, at a place so slightly elevated above the level of the sea, merely by passing through a quantity of loose materials, whose mean temperature cannot be less than 46 *.

In the case of the icy caverns, however, there is room for a wider range of conjecture. Among the various opinions which might be advanced to explain the cause of their depressed tem-

* The mean temperature of Rome is, according to Humboldt, 45°.9 in winter, and 55°.2 in summer.

perature, it would imply no extravagance of supposition to take it for granted that these subterraneous recesses are connected by means of horizontal crevices, running inwards to a great extent, with vertical fissures ascending in some adjacent mountain, to a height above the line of perpetual congelation. The great distance under ground to which several of the caverns in calcareous rocks have been traced, permits us to indulge the conjecture, that, in many instances, they may proceed far beyond the limits to which they have actually been explored; and, as we are certain that, in some cases, they penetrate several miles through the solid strata, it is easy to imagine that rents proceeding from them may branch off, in a vertical direction, to the very summit of the mountain in which they occur, or at least to a height beyond the regions of perpetual congelation. This state of things would be quite consistent with the fact, affirmed to be observed in all the icy caverns, that more ice is formed in them during summer than in winter; as the current of air flowing downward ought to be most powerful, and consequently the cold induced greatest, when the difference between the temperature of the atmosphere at the mouth of the cave, and at the opening of the vertical crevices, where the air is supposed to enter, is greatest. Nor does this hypothesis exclude the influence of evaporation in contributing to the effect; on the contrary, it admits its operation in the only circumstances under which it could possibly act, namely, when the humidity of the air, before it entered the crevices which conduct it to the cavern, is less than what it possesses at the freezing point. In no other case could evaporation reduce the temperature of a moistened surface to that point.

Art. XVII.—*Tables of the Variation of the Magnetic Needle in different parts of the Globe.* (Continued from Vol. IX. p. 447.)

Table IV. *Containing the Variation of the Needle as observed in France.*

Names of Places.	Year of Observation.	Magnetic Variation.	Names of Places.	Year of Observation.	Magnetic Variation.
Antibes,	1682	3° 40′ W.	Paris,	1697	7° 40′ W.
Bayonne,	1680	1 20		1698	7 40
Boulogne,	1767	17 26		1699	7 50
Brest,	1679	1 45		Oct.	8 10
	1771	20 10		1700	7 40
	1798	25 30		Nov.	8 12
Calais,	1681	4 30		1701	8 25
	1767	19 30		Sept.	8 48
Dieppe,	1619	6 30 E.		1702	8 48
Dunkirk,	1767	18 33 W.		Oct.	8 50
Havre de Grace,	1767	19 15		1703	9 0
	1782	22 15		Dec.	9 6
Marseilles,	1761	18 0		1704	9 20
	1798	20 55		1704	9 20
St Maloes,	1681	2 0		1705	9 25
Montpellier,	1674	1 10		July	9 30
Ushant Island,	1776	23 1		Dec.	9 35
Paris,	1541	7 0 E.		Dec.	10 0
	1550	8 0		1706	9 48
	1580	11 30		1707	10 10
	1603	8 45		1708	10 15
	1610	8 0		Dec.	10 15
	1630	4 30		1709	10 40
	1640	3 0		Dec.	10 30
	1642	2 30		1710	10 50
	1659	2 0		Dec.	10 50
	1660	1 0		1711	11 0
	1664	0 40		Dec.	10 50
	1666	0 0		1712	11 25
	1667	0 15 W.		Dec.	11 15
	1670	1 30		1713	11 40
	1680	2 40		Dec.	11 12
	1681	2 30		1714	12 0
	1682	2 30		Dec.	11 30
	1683	3 50		1715	11 10
	1684	4 10		1716	12 15
	1685	4 10		Oct.	12 30
	1686	4 30		Dec.	12 30
	1687	5 12		1717	12 45
	1688	4 30		Dec.	12 40
	1689	6 0		1718	12 30
	1691	4 40		Dec.	12 30
	1692	5 50		1719	12 30
	1693	6 20		1720	13 0
	1695	6 48		1721	13 0
	1696	7 8		Oct.	13 0

TAB. IV.—*Continued.*

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.	NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Paris,	1722	13° 0′W.	Paris,	1773	20° 4′W.
	Nov.	13 0		April	20 0
	1723	13 0		1774	20 17
	Dec.	13 0		Aug.	20 12
	1724	13 0		1777	20 27
	1725	13 0		1778	20 37
	Oct.	13 15		Dec.	20 41
	Dec.	13 15		1779	20 31
	1726	13 45		June	20 35
	1727	14 0		July	20 33
	1728	13 50		Aug.	20 40
	1729	14 10		Aug.	20 31
	1730	14 25		Nov.	20 35
	1731	14 45		1780	20 35
	1732	15 15		Mar. 27.	20 45
	1733	15 45		May 5.	20 40
	1734	15 35		16.	20 42
	Dec.	15 40		17.	20 49
	1735	15 45		18.	20 42
	Oct.	14 55		19.	21 4
	1736	15 40		20.	20 49
	Dec.	15 40		21.	20 45
	1737	14 45		22.	20 42
	1738	15 10		23.	20 57
	Feb.	15 20		24.	20 44
	1739	15 30		25.	20 48
	1740	15 45		26.	20 46
	Dec.	15 30		27.	20 47
	1741	15 40		28.	20 43
	1742	15 40		29.	20 47
	Sept.	15 10		31.	20 42
	1743	15 10		June 1.	20 45
	1744	16 15		2.	20 45
	1745	16 15		3.	20 48
	1746	16 15		4.	20 39
	1747	16 30		5.	20 49
	1748	16 15		7.	20 39
	1749	16 30		9.	20 39
	1750	17 15		13.	20 48
	1751	17 0		16.	21 4
	1752	17 15		18.	20 43
	1753	17 20		19.	20 45
	1754	17 15		22.	20 54
	1755	17 30		24.	20 50
	1757	18 0		25.	20 42
	1758	18 0		26.	20 39
	1759	18 10		27.	20 42
	1760	18 30		28.	20 38
	1765	19 0		30.	20 44
	1770	19 55		July 3.	20 36
	1771	19 50		5.	20 51
	1772	20 12		7.	20 39
	Nov.	20 2		8.	20 44

Tab. IV.—*Continued.*

Names of Places.	Year of Observation.	Magnetic Variation.	Names of Places.	Year of Observation.	Magnetic Variation.
Paris,	Aug. 16.	21° 0′ W.	Paris,	1792	22° 45′ W.
	Sept. 19.	20 45		1793	22 49
	21.	20 50		1798	22 17
	22.	20 42		1799	22 49
	23.	20 46			22 0
	Dec. 19.	20 56		1800	22 12
	1781	20 47		1801	22 1
	Jan. 27.	20 40		1802	21 45
	Mar. 7.	20 47		1802	22 3
	April 1.	20 59		1802	21 46
	17.	20 50		1803	21 59
	May 8.	20 51		1804	22 5
	12. & 29.	20 51		1804	22 15
	June 23.	20 57		1807	22 34
	Oct. 8.	21 3		1814	22 34
	1782	21 1		1816	22 25
	June 28.	21 16		1817	22 17
	July 4.	21 12		1818	22 21,6
	1783	21 12		1819	22 29
	June 23.	21 22	Royan,	1680	1 20
	Aug. 5.	21 27	Toulon,	1682	3 45
	1784	21 27	Toulouse,	1747	15 10
	Feb. 29.	21 24		1748	15 0
	1785	21 35		1749	15 10
	1786	21 37		1750	16 5
	June 21.	21 27		1751	16 0
	1789	21 56		1752	15 45
	1790	22 0		1753	16 45
	1790	21 52		1754	16 40
	1791	22 2		1755	15 0
	1791	22 4		1756	15 45

Table V. *Containing the Variation of the Needle, as observed in Great Britain and Ireland.*

Names of Places.	Year of Observation.	Magnetic Variation.	Names of Places.	Year of Observation.	Magnetic Variation.
Bristol,	1666	1° 27′ W.	Dublin,	1745	18° 0′ W.
	1667	1 33		1751	19 0
Bushey Heath,	1813	24 22 17		1772	23 30
	1814	24 22 48		1786	26 21
	1815	24 27 18		1788	26 50
	1817	24 42 14		1790	27 15
	1818	24 45 11		1791	27 23
	1819	24 41 41		1804	26 30
	1820	24 39 16	Edinburgh, Oct. 29.	1808 *	27 31 49″
	1820*	24 36 34	Nov. 3.	1809 *	27 35 10
	1822	24 35 26	Sept. 29.	1812 *	28 8
			July 9.	1823 †	27 48

*According to Mr James Jardine's observations.

† According to Professor Wallace's observations.

Tab. V.—*Continued.*

Names of Places.	Year of Observation.	Magnetic Variation.
Hermitage Hill*,	1823	27° 0′ W.
London,	1580	11 15 E.
	172[illegible]	5 56½
	1634	4 6
	1657	0 0 W.
	1665	1 22¼
	1672	2 30
	1692	6 0
	1723	14 17
	1745	17 0
	1745	17 0
	1746	17 10
	Dec. 18.	17 25
	1747	17 30
	1747	17 40
	1748	17 40
	1773	21 9
	1774	21 16
	1775	21 43
	1786	23 17
	1787	23 19
	1788	23 32
	1789	23·19
	1790	23 39
	1791	23 36
	1792	23 36
	1793	23 49
	1794	23 56
London,	1795	23° 57′ W.
	1796	24 0
	1797	24 1
	1798	24 0,6
	1799	24 1,8
	1800	24 3,6
	1801	24 4,2
	1802	24 6,7
	1803	24 8,8
	1804	24 8,4
	1805	24 8,8
	1809	24 11,0
	1814	24 16,7
	July	24 17,9
	Aug.	24 21,2
	Sept.	24 20,5
	1815	24 17,8
	1816	24 17,9
	1817	24 17
	1818	24 15,7
	1819	24 14,8
	1820	24 11,7
	1821	24 11 18″
	1822	24 9 55
	1823	24 9 48
Plymouth,	unknown	13 24 E.
	1733	13 27 W.
Stromness Harbour,	1774	24 0

Tab. VI. *Containing the Variation of the Needle as observed in Portugal, Spain, and Italy.*

Names of Places.	Year of Observation.	Magnetic Variation.
Aranjuez,	1798	19° 25′ W.
Alborne Island,	1733	14 12
Braga,	1761	16 15
Brescia,	1676	4 0 E.
Cadiz,	1724	5 25 W.
	1769	17 15
	1769	18 40
	1771	18 0
	1776	19 42
	1791	21 56
Cape St Vincent,	1733	13 49
Cape St Gatt, Sp.	1733	13 56
Cape St Mary's, P.	1734	14 20
Cape Finisterre,	1589	7 40 E.
	1768	21 4 W.
Cape St Antonio, S.	1792	19° 23 W.
Ferrara,	1677	2 0
Gibraltar Bay,	1733	13 38
	1761	17 11
	1792	22 6
Lisbon,	1638	7 39 E.
	1668	0 50 W.
	1683	3 0
	1697	4 18
	1706	6 30
	1762	17 32
	1776	19 0
	1782	19 51
Loretto,	1756	15 35
Madrid,	1799	19 59

* Near Leith, according to Mr Andrew Waddell's observations

Tab. VI.—*Continued.*

Names of Places.	Year of Observation.	Magnetic Variation.	Names of Places.	Year of Observation.	Magnetic Variation.
Malta, -	1694	9° 15′ W.	Rome, -	1695	7° 30′ W.
		9 45		1730	11 0
	1708	10 25		1782	16 49
Minorca, C. Mola,	1733	14 34		1783	16 49
Padua, -	1725, 1730	13 0		1784	16 54
				1785	17 0
	1770	16 20		1786	17 4
Rome, -	1670	2 15		1787	17 7
	1681	5 0		1788	17 12

Table VII. *Containing the Variation of the Needle, as observed in Turkey in Europe.*

Names of Places.	Year of Observation.	Magnetic Variation.	Names of Places.	Year of Observation.	Magnetic Variation.
Akiermann, -	1771	9° 25′ W.	Ofen, -	1781	16° 45′ W.
Bender, -	1772	9 45		1783	15 58
Bucharest, -	1772	11 36		1782	15 36
Constantinople,	1600	0 0		1784	15 40
	1625	2 0		1785	15 48
	1691	9 0		1787	16 26
		12 0		1788	16 36

(To be Continued.)

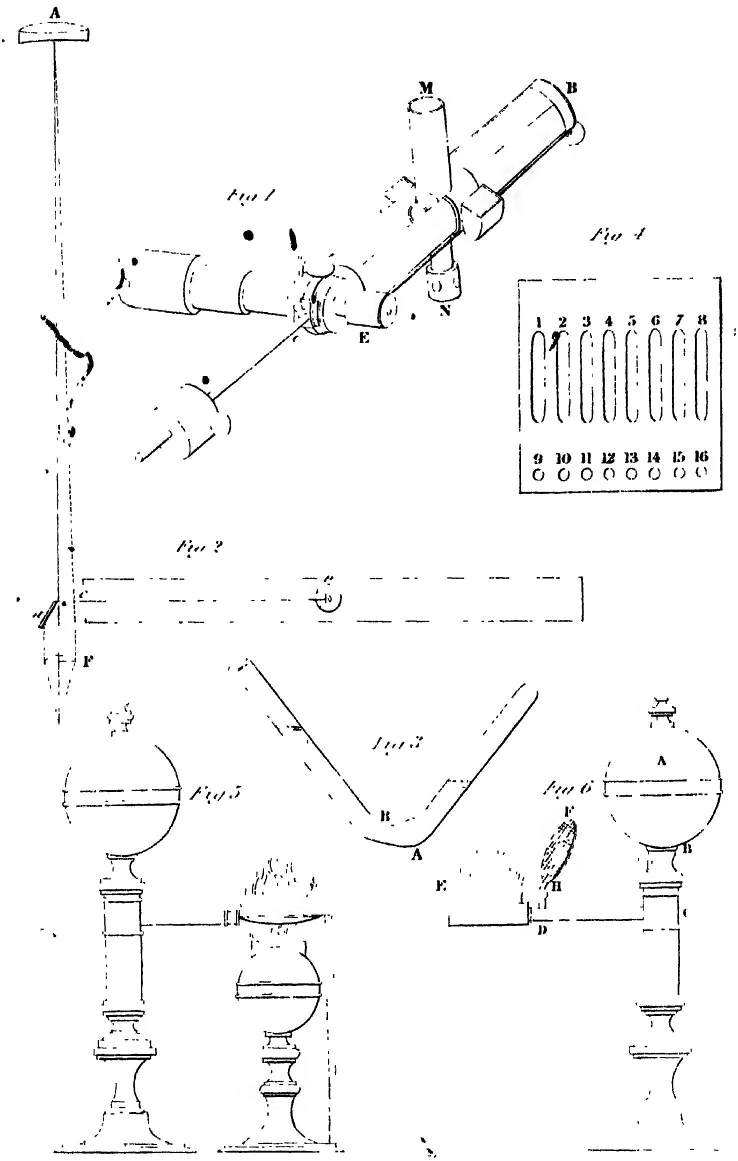
Art. XVIII.—*Description of a Monochromatic Lamp for Microscopical and other purposes* *, *&c.* By David Brewster, L. L. D. & Sec. R. S., &c.

In a Paper on Vision through coloured Glasses †, which I had lately the honour of submitting to the Society, I pointed out the advantages of coloured media in Microscopical and Telescopical observations. Having experienced the great utility of *Green* and *Red* lenses, in developing vegetable structures that required to be examined with high powers, I was anxious to derive from this new principle all the advantages which it appeared to possess. In attempting to do this, it became necessary

* Abridged from the *Edinburgh Transactions*, vol. ix. p. 433.

† See this *Journal*, vol. VI. p. 102.

PLATE II.



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to ascertain the power of giving distinct vision, which belonged to each separate colour of the spectrum, and though I had stated in my former paper, "that it was difficult to discover "any reason why one coloured medium should be preferred "to another, provided each of them transmit equal quantitites "of homogeneous light;" yet it was desirable to put this theoretical opinion to the test of direct experiment. Sir William Herschel * had long ago investigated this point, in reference to the use of coloured media for solar observations, and had concluded *that every colour of the spectrum possessed the same power of giving distinct vision*; but his method of observation, which consisted in viewing through a miscroscope a Nail illuminated in succession with each of the colours of the prism, was by no means calculated to give definite results, and therefore left the question in all its uncertainty.

In order to obtain precise indications, which were not capable of being misinterpreted, when applied to practical purposes, I formed a spectrum from a luminous disc, by means of a prism of a highly dispersing substance, and with a large refracting angle. I then examined this spectrum through a great variety of coloured media, both solid and fluid, and marked the size and shape of the image into which it was converted. The perfection of this image, or its narrowness in the direction of the length of the spectrum, became a precise and unequivocal test of the fitness for distinct vision which belonged to the light out of which it was formed.

By this method of observation, I found that a distinct image of the luminous disc could not be obtained either by producing a blue or a green image, and that it was only in the red portion of the spectrum that such an effect was likely to be obtained. In the use of purple glasses, I observed that the middle portion of the red space was absorbed before the two extreme portions, so that instead of one red image there were two quite separate, and tolerably distinct. By increasing, however, the thickness of the plate, the most refrangible red image was absorbed, and the least refrangible one left in a state of the most perfect distinctness. Although I had now determined the part of

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* *Philosophical Transactions*, 1800.

the spectrum that was best fitted for giving perfect vision, yet the quantity of light extinguished before the insulation of the extreme red ray was affected, was so great as to render the determination of little practical utility, excepting in cases where the outline of an object was to be observed. Had it been possible to insulate the *most luminous rays of the spectrum* as perfectly as the extreme red ones, the advantage would have been of very considerable amount; but I have found this quite impracticable, and I venture to say, that the separation of homogeneous green or homogeneous yellow light, of any considerable intensity, cannot be effected by any coloured media with which we are at present acquainted.

Abandoning, therefore, all hopes of obtaining from coloured media any farther improvement upon the microscope than what I had formerly announced, it occurred to me, that the object which I had in view might be obtained, if I could procure, from the combustion of inflammable substances, *a homogeneous flame for illuminating microscopic objects.*

It had long been known, that a great quantity of homogeneous yellow light was created by placing salt or nitre in the white flame of a candle, or in the blue and white flame of burning alcohol *. A light, however, generated in this manner, was more fitted for a casual experiment, than for a permanent source of illumination; and as insalubrious vapours are disengaged during the combustion of these salts, I did not avail myself of this method of obtaining yellow light.

After numerous experiments, attended with much trouble and disappointment, I found *that almost all bodies in which the combustion was imperfect, such as paper, linen, cotton, &c. gave a light in which the homogeneous yellow rays predominated;*—that the quantity of yellow light increased with the humidity of these bodies;—and that a great proportion of the same light was generated, when various flames were urged mechanically by a blowpipe or a pair of bellows.

* *Edinburgh Physical and Literary Essays*, vol. ii. p. 34.; and Dr Thomas Young's *Nat. Phil.* vol. i. p. 438. Mr Herschel informs me, that sulphur in a certain stage of its combustion produces a homogeneous yellow light.

As the *yellow* rays seemed to be the product of an imperfect combustion, I conceived that alcohol diluted with water would produce them in greater abundance than when it was in a state of purity, and upon making the experiment, I found it to succeed beyond my most sanguine expectations. The whole of the flame, with the exception of a small portion of blue light, was a fine homogeneous *yellow*, which, when analysed by the prism, exhibited faint traces of green and blue, but not a single ray of red or orange light. The green and blue rays which accompanied the yellow flame, had comparatively so little intensity, that they disappeared in the processes of illuminating and magnifying the object under examination; and, even if they had existed in greater abundance, it was quite easy to absorb them at once by the intervention of a plate of the palest yellow glass, and thus render the lamp perfectly monochromatic.

From many experiments on the combustion of diluted alcohol, I found that the discharge of yellow light depended greatly on the nature of the wick, and on the rapidity with which the fluid was converted into vapour. A piece of sponge, with a number of projecting points, answered the purpose of a wick better than any other substance, and the extrication of the yellow light became more copious, by placing a common spirit-lamp below the burner of the other. In order to obtain a very strong light for occasional purposes, I connected with the top of the burner a frame of wire-gauze, which, by moving vertically round a hinge, or by a motion to one side, could be placed in a horizontal position about half an inch above the wick. As soon as it had become red-hot, it was made to descend into contact with the sponge, when it converted the alcohol rapidly into vapour, and produced an abundant discharge of yellow light. See Plate II. Fig. 5.

If a permanently strong light is required, I find it preferable to dispense entirely with the use of the wick, and to allow the diluted alcohol to descend slowly from the rim into the bottom of a concave dish of platinum, kept very hot by a spirit-lamp placed beneath it. The bottom of the dish is made with a number of projecting eminences, in order that the film of fluid which rests upon it may be exposed at many points to the action of the heated surface. See Fig. 6. After the lamp has burned for

some time, a portion of unevaporated water, mixed with a small quantity of alcohol, will remain at the bottom of the dish, in a state unfit for combustion. This water may be taken up by a sponge, or it might be prevented from accumulating, by having a fountain of pure alcohol, from which the exhausted strength of the diluted fluid could be renewed.

The *monochromatic lamp* being thus completed, I lost no time in applying it to the illumination of microscopic objects. The effect which it produced far exceeded my expectations. The images of the most minute vegetable structures were precise and distinct, and the vision in every respect more perfect than it could have been, had all the lenses of the microscope been made completely achromatic by the most skilful artist.

Independent of its use in microscopical observations, the *monochromatic lamp* will find an extensive application in various branches of the arts and sciences. In certain cases of imperfect vision, where a number of coloured images are formed by the separation of the fibres of the crystalline lens, a homogeneous light will improve the vision, by removing the prismatic tints, which obliterate the principal image. In illuminating the wires of transit instruments and micrometers;—in graduating the limbs of divided instruments, which is generally done by candle-light;—in reading off the same divisions in fixed observations;—in forming signals in trigonometrical surveys;—in obtaining correct and uniform measures of refractive powers;—in measuring the separation of the two pencils in doubly-refracting crystals;—in determining the focal lengths of lenses;—in observing various optical phenomena, where the light is decomposed;—in these, and, in general, in all delicate works, where correct vision is essential, the employment of a homogeneous flame will be found to confer the most signal benefits.

Explanation of Fig. 5, 6. of Plate II.

Fig. 6. Represents one form of the monochromatic lamp, where A is the reservoir containing the diluted alcohol, which descends by the channel ABCD to the broad wick E, which is generally made of sponge. A frame of wire-gauze F moves round a hinge H, so that it can be brought over the flame, and made to descend, when hot, upon the

surface of the wick. Excellent wicks may be made with concentric cylinders of thin mica, or of platinum foil.

Fig. 5. Is another form of the lamp, *without a wick*, in which the diluted alcohol is burned in a flat platinum or metallic dish MN, which may be made to have a slight spontaneous oscillatory motion, for the purpose of bringing the fluid over the heated projections of the platinum. A common spirit-lamp OP, inclosed in a case, is placed below the platinum dish MN, in order to produce sufficient heat for throwing off the vapour from the diluted alcohol.

A chimney, or a cylinder, of pale yellow glass may be placed round the flame, if it should be thought of any consequence to absorb the small portion of blue light which accompanies the yellow flame.

Art. XIX.—*Biographical Notice of Mary Noble of Penrith, Cumberland, who is* (1823) *in the* 107*th Year of her Age, with some Remarks on Longevity* *. By Thomas Barnes, M. D.

Mary Noble, the subject of the following brief Memoir, was born at Haresheugh, in the parish of Kirkoswald, Cumberland. Her parents were poor labouring people, of the name of Salkeld, and were chiefly employed in agriculture. Both of them lived to be very old, and had ten children; several of whom, also, reached a very advanced age. A copy of the register of her baptism was lately shewn to me by Jonathan Nicholson of Penrith, with whom she now resides. Her baptism is dated September 17. 1716; and as children, at that time, were seldom baptised immediately after their birth, it is probable she was born two or three months before. She was brought up with plain and simple food; and was accustomed, from her youth, to industry and hard labour. At thirty years of age she married to William Noble, a miller, by whom she had three children; all of whom died of acute diseases, in their infancy. Mary Noble is a very short and small woman; and, at present, would not weigh more than between four and five

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* Read before the Wernerian Natural History Society, 31st May 1823.

stone. Old age is strongly marked in her countenance and general appearance. Her forehead and face are much wrinkled; her eyes are clear, but her eyelids are partially everted and affected with lippitude; she has had no teeth these twenty years, but her gums are so firm, that she can masticate a piece of hard bread with comparative ease; her hearing began to fail about three years ago, and has since gradually declined; for the last three months she has been very deaf, and at present can scarcely hear any thing; her sight is still good; three years ago it was so good, that she had no occasion for glasses, and could thread a small needle; her hair, which is flaxen, of a leaden cast, is thick and long, and has undergone very little change; it has been a source of profit to her, as she has frequently sold a crop of it for 10s., 15s., and even 20s. She had always a retentive memory; when 106 years old, it was perfect, and she used to relate an account of the second Rebellion; she said she remembered it well; at that time she resided at Stockbridge as a servant, and saw some of the rebels hung on Penrith Fell. Mary Noble is a poor scholar, but can read a little; and occasionally reads her Bible. For the last four or five years she has used a stick in walking; but walks perfectly upright. There is no contraction of her limbs. Her pulse is regular, of good strength, and beats about 90 in a minute. Her respiration is easy and uniform. She sleeps much, has a good appetite, and generally has an alvine evacuation twice or three times a-week; but sometimes only once. She has led an active and industrious life; and in general has enjoyed good health. She never had any blood drawn, nor took any medicines, excepting once an opium pill, for a cough, which made her so sick and ill, that her life was almost despaired of. Her husband rented a corn-mill at Melmerby, and she was then in the habit of rising at three o'clock in the morning, and going with carts to Alston, a distance of eleven miles over one of the wildest, coldest, and most dreary parts of Cumberland. When she was seventy-two or seventy-three years of age her husband died, and she was afterwards employed as housekeeper to a farmer at Old Town. She then regularly drove ponies laden with corn, to Carlisle and Penrith markets; each place being about nine miles distant from her residence. When ninety years of age, she used to reap during the harvest; the

person with whom she is now living tells me, she would walk a mile to the field, carry her ridge with the other reapers, and walk home at night. From her youth her chief employment has been spinning and working in husbandry; and she has been very active and laborious. Her diet has been of the plainest kind; she generally lived abstemiously, but did not object to drink a little ale or spirits occasionally. For some years past she has lived chiefly upon tea, which she likes strong, and takes with cream; but without sugar. Sometimes she has a little milk or broth, but tea is her favourite food; and she has often taken it three times a day. She began to drink tea about sixty-five years ago, when she had a present of some made to her by Mr Pattinson of Melmerby. She used, at that time, to boil it in the kettle. She has always been accustomed to a warm dress, and generally wore flannel next her shift. Within the last three years she rose early in the morning, cleaned the fire-irons, put on the fire, and wrought all kinds of house-work. Until three months ago, she spun linen-yarn with a spinning-wheel, which is a common occupation among the peasantry of Cumberland. The yarn she span was fine, and of a good quality. I lately saw a very handsome table-cloth that had been made of it; and it is worthy of remark, that this table-cloth was spun by her when 106 years of age, and was woven by a blind man.

Mary Noble has resided, for the last seventeen years, with Jonathan Nicholson of Penrith, who is now seventy-six years old, and remembers her from his youth. His wife, who is sixty-nine years old, was nursed by her when a child; which circumstance gave rise to a strong attachment, and in return, his wife nurses her in her old age, and affords her every attention and comfort: they have lived together during the last thirty-two years. This old woman has been many years in great poverty, but never applied for parish relief: her own industry, the kindness of her friends, and the protection of Jonathan Nicholson and his wife, have provided her with all the comforts and conveniences of life.

It is the lot of very few persons to reach the age of this venerable old woman; few are born with a constitution so strong and healthy as she had; many are cut off in childhood by the diseases to which children are liable; and many fall victims to

their own intemperance, to unwholesome occupations, to severity of climate, to infectious diseases, and dangerous accidents. This woman has been singularly fortunate in possessing originally a good constitution, in living an active and temperate life, and in escaping the diseases and accidents to which the human body is so often exposed. Notwithstanding the many circumstances that abridge life, it is not at present a very rare thing to meet with persons upwards of 100 years of age, and it is a mistaken notion to suppose, that men do not live so long now as formerly. When the population of Great Britain was taken in 1821, there were in England 57 men and 111 women, of 100 years of age and upwards; in Wales, there were 3 men and 18 women; and in Scotland, 40 men and 62 women; making a total of 291 persons. But the ages of one-ninth part of the population were not obtained, nor is the exact age of any individual mentioned; so that we cannot ascertain, from the returns, how much some of them might exceed a century. It is stated, that many of them were upwards of 100; but as no question was proposed by the returning officers, respecting the age of any person above 100, so no answer has been made to that effect. The counties of England, in which the most cases of longevity were met with, in proportion to the number of inhabitants, were Durham, Northumberland, Cumberland, Monmouth, Hereford, and the North Riding of York. In Scotland, the shires of Ross and Cromarty, and Inverness, furnished the greatest number of instances; and in Wales, the counties of Brecon and Pembroke. The age of man, as recorded in history, has been nearly the same since the time of Moses. Before his time, it is stated in the Bible that some men lived many hundred years; but the natural period of human life, or the limit of old age, as marked out by him in his prayer, is as applicable to men in the present day, as it could be at the time in which he lived. "The days of our age," says he, "are three score years and ten, and if, though men be so strong, that they come to four score years, yet is their strength but labour and sorrow." Moses himself lived 120 years; and several persons, after his time, are mentioned in Scripture, who lived to a much greater age. Profane history also affords us many instances of persons above 100 years old, but it is not stated, that it was at any time a common occurrence for

men to live to so great an age, or that men in general lived at any time longer than at present: indeed, we have strong reasons to believe that mankind live longer now than formerly; in England, at least, this is undoubtedly the case. The salubrity of England has considerably increased, and the mortality diminished, for many years past. The results of the population-acts afford satisfactory evidence, that our ancestors did not enjoy the same degree of health and longevity that we do at present. The annual mortality has decreased nearly one-third in forty years. In 1780, the rate of mortality was taken at one in forty; in 1795, at one in forty-five; in 1801, at one in forty-seven; in 1811, at one in fifty-two; and in 1821, the results of the census shew a mortality of one in fifty-eight. The limits of human life are the same now as formerly, and will probably always continue the same, but more persons live now to an advanced age than in former times.

Man is by nature a mortal being, and it is not in the power of art to make him immortal; yet art has done much in preserving and restoring his health, and in increasing the duration of his life. Various have been the measures that have contributed to produce these effects; the principal of which are, the improvements that have been made, in modern times, in our food and clothing, in the cleanliness of our houses and towns, in the drainage of the country, and in the treatment and prevention of diseases. This country has become more favourable to health and longevity, since more attention has been paid to the cleanliness and ventilation of our houses and large towns; and since warmer clothing, and a more nourishing and more easily digestible diet, have been employed. Some of the most formidable and fatal diseases that prevailed in former times are now either extinct, rarely met with, or much mitigated in their violence; such as the plague, dysentery, scurvy, malignant, intermittent, and remittent fevers, and smallpox. A few diseases, it is true, have lately become more frequent and fatal; such as consumption and apoplexy, but these not being infectious, like some of the others, are of much less consequence.

On reviewing the various instances of longevity on record, it appears, that the circumstance most necessary to secure long life, is to be born of parents who enjoy good health, and are predis-

posed to live to a great age. Children, it is well known, frequently inherit the constitutions and diseases of their parents. Many persons, who have attained to extreme old age, were born of parents who were themselves long livers; which renders it highly probable, that longevity is in a great degree hereditary. The next circumstances, most conducive to health and long life, are plain wholesome diet, temperance, warm clothing, and regular exercise in the open air. Very few persons who are intemperate and irregular, or lead an idle and sedentary life, possess good health, or ever attain to advanced years.

CARLISLE, }
May 1823. }

ART. XX.—*Notice respecting some New Electro-magnetic Phenomena.* By Major-General BARON VAN ZUYLEN VAN NYEVELT *.

IN a former number (Vol. IX. p. 167.), we have laid before our readers an account of the Electro-magnetic Experiments made by Baron Van Nyevelt, Professor Moll, &c. In pursuing this inquiry, the first of these philosophers has found that he can produce very decided effects on the inclination or dip of the magnetic needle, by means of the simple apparatus which we have already described †.

In order to produce this effect, the strips of metal, instead of being placed the one above the other, as in the experiments already referred to, are placed the one alongside of the other, but at such a distance as to leave sufficient room for the dipping-needle to be placed between them. In order that the electro-magnetic action may be the same throughout the whole length of the needle, the strips of metal are placed on the angle of inclination, by placing the whole apparatus in the direction of the magnetic meridian.

With this apparatus Baron Van Nyevelt obtained the results given in the following Table

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* Abridged and translated from the *Bibliothèque Universelle*, August 1823, p. 274.

† See Vol. IX. of this Journal, Plate IV. Fig. 7—15.

Designation of the Apparatus.	When the two ends are plunged in the liquid.	When another piece of metal is applied upon one of the ends.					
		Upon the end *a*.			Upon the end *b*.		
		Zinc.	Copper.	Iron.	Zinc.	Copper.	Iron.
Zinc & Copper. The zinc strip is below, and the copper one passes above.	Declination East 30°	- -	- -	Declination East 5°	- -	- -	Declination East 5°
Zinc & Copper. The zinc to the east, and the copper to the west.	Inclination South 10°	- -	- -	Inclin. effect doubtful.	- -	- -	Inclin. effect doubtful.
Zinc & Copper. The zinc above, and the copper passing below.	Declination West 30°.	- -	- -	Declination West 5°	- -	- -	Declination West 5°
Zinc & Copper. Zinc to the west, copper to the east.	Inclination North 10°.	- -	- -	Inclin. effect doubtful.	- -	- -	Inclin. effect doubtful.
Zinc alone. The strips above each other.	- - -	- -	Declination East 45°	Declination East 45°	- -	Declination West 45°	Declination West 40°
Zinc alone. The strips alongside one another.	- - -	- -	Inclination S. 10°	Inclination S. 10°	- -	Inclination Nor. 10°	Inclination Nor. 10°
Copper alone. The strips above each other.	- - -	Declination West 30°	- -	Declination W. 15°	Declination East 30°	- -	Declination East 10°
Copper alone. The strips alongside one another.	- - -	Inclination Nor. 15°	- -	Inclination North 5°	Inclination S. 10°	- -	Inclination South 5°
Iron alone. The strips above each other.	Declination East 10°.	Declination W. 100°	Declination West 5°	- -	Declination E. 110°	Declination East 10°	
Iron alone. The strips alongside one another.	Inclination South 5°.	Inclination S. 02°	Inclination South 5°	- -	Inclination N. 15°	Inclination N. 5°	

Observations.—In these results, no notice is taken of the contacts with the same metal, the effect being merely increased in proportion to the quantity of surface exposed to the liquid.

When the two ends of the strips are united under the acid, the effect is *diminished* in the first *four* of the preceding apparatuses, and destroyed in the last *six* apparatuses.

Art. XXI.—*Observations on the Anatomical Structure of the Cassowary of New Holland* (Casuarius Novæ Hollandiæ, *Cuv.*) By Robert Knox, M. D. F. R. S. E *.

An opportunity having occurred to me lately, of examining, though in a cursory manner, both species of Cassowary at present known, viz. that found in the Indian Islands, and long since described under the name of the Galeated Cassowary, and the species lately discovered in Australasia, and generally distinguished by the name of Emeu Casuary, some remarkable differences in the internal structure presented themselves, confirmative of an opinion already formed by naturalists, that these birds constitute distinct species. I shall limit myself to a very brief notice of these differences, as well because the specimens were greatly mutilated, and the time allowed for the dissection (owing to the weather) very short, as likewise because leisure is wanting to enable me to become acquainted with the dissections of the same species of birds which may have been performed by others.

On referring to the *Systema Naturæ* of Linnæus, I find that the Emeu of New Holland was unknown to him. It is slightly mentioned by Professor Blumenbach, in his Manual of Natural History, as a new species lately discovered in New Holland, but it is not described. The compilers of the "*Dictionnaire des Sciences Naturelles*," describe the bird at some length, as being a new species, quite distinct from the Galeated Cassowary or *Struthio Casuarius* of Linnæus. No mention is made of the internal structure in either bird. The "*Regne Animale*" of Baron Cuvier describes these birds as forming two distinct species, and which might even be considered as genera. They are characterized by the names of *Struthio Casuarius* and *Casuarius Novæ Hollandiæ*. No mention is made of the internal structure in the latter. Finally, in the celebrated "*Leçons d'Anatomie Comparée*," one species only is mentioned, viz. the Galeated Cassowary.

After this very brief notice of the history of these birds, I shall proceed to compare their internal structures. The carcases, in both specimens, were extremely fat, and the abdominal cavity remarkably so. They were females. The galeated cassowary had

* Read before the Wernerian Natural History Society, 26th April 1823.

died of inflammation of the lungs and air-cells in the bottom of the neck. The investing membrane was excessively vascular; and the lymph, effused over a very extensive surface, had assumed, as is usual, the form of a membrane. There was little or no effusion. The cause of death did not appear on the dissection of the New Holland Cassowary. It will be readily imagined, that I did not even attempt to look at the nervous system, since the only parts which came properly under my inspection were the viscera, cut from the back-bone, and dragged out through the abdominal cavity.

Of the organs of sense, the only one I had it in my power to examine was that of vision. Many interesting appearances presented themselves, to detail which would be foreign to the object of this notice, and would, moreover, interfere with a memoir I am preparing on the anatomy and physiology of this organ. I shall therefore merely mention, that the examination of the eye in the Galeated and New Holland Cassowary, confirmed all my previous observations on the eyes of birds, the principal of which go to prove, that the marsupium, by some considered a muscle, is simply a membranous expansion reflected by the choroid, and quite continuous with it; that the white lines of nervous matter at its base, to which so much importance has been attached by some, are occasioned by the dissection, and are not natural to the organ; that there is a perfect analogy between the marsupium in birds and in many fishes; that the annulus albus, or ciliary ligament, supposed by some distinguished anatomists to be a nervous plexus or ganglion, is a muscular body, and is principally concerned in enabling the eye to adapt itself to the perception of objects placed at various distances.

The salivary glands have been already sufficiently described. The tongue, in each, is small, triangular, and has on its edges a number of soft projecting fringe-like bodies. The hyoid bone is also small, corresponding with the dimensions of the tongue, and with its comparative immobility. A true membranous crop can hardly be said to exist, since the gullet dilates uniformly until its termination in the ventriculus succenturiatus or glandular crop. This latter is divided, as in the ostrich, into two portions, viz. one possessing glands, and one without apparent secreting organs, placed between the former and the gizzard. The por-

tion of the general bag of the stomach, which has no gastric glands, is much larger in the cassowary of New Holland, than in the Indian cassowary; or, in other words, the glandular crop approaches much nearer the gizzard in the latter than in the former. The gizzard is weak in both. I consider this as a character distinguishing these birds from the ostrich. It is true, that they must long since have ceased to be fed agreeably to their natural disposition; and this, according to the opinions of Mr Hunter, may have had some effect in diminishing the muscularity of the gizzard. I must suppose it owing to the same cause, that the gizzard of the ostriches I have dissected on their native desarts, always appeared to me very muscular, whilst others, who have examined the same bird, after being long in a state of captivity, describe the gizzard as not being remarkably so. It must, however, be evident to all, that the ostrich is strictly graminivorous, whilst the food of the cassowaries of India and New Holland is, without doubt, chiefly composed of insects and reptiles.

The proportional lengths of the intestinal tube, in feet and inches, are as follows:

NAME.	Length of the Animal from the Bill to the extremity of the Coccyx.	Length of the Intestinal Canal to the insertion of the Cœca.	Length of each Cœcum.	Length of the Intestinal Canal from the Insertion of the Cœca to the Anus.	Whole length of the Intestinal Canal, including the Cœca.	Length from the insertion of the Biliary Ducts to that of the Cœca.	Ratio of the length of the Intestinal Canal with that of the Body.
	Ft. In.	Ft. In.	Ft. In.	Ft In.	Ft. In.	Ft. In.	
Ostrich,—Cuv.	6 4.69		2 1.5	...	49 0.0		: : 1 : 8
Galeated Cassowary.—Cuv.	3 8.72	4 7.35	0 5 82	0 10.63	6 5.95		: : 1 : 1.7
—— R. K.		4 6	0 5½	1 6	9 6	3 6	
Cassowary of New Holland. R. K.	...	16 nearly.	0 5½	1 6	22 0	14 0	

In both birds the cœca resemble each other closely; they are very small, and the orifices by which they penetrate the intestines are so narrow, that air blown into the intestines cannot be forced into the cœca: their parietes are thin and delicate, and they con-

tain a fluid matter differing very much from the usual contents of the intestinal tube. The form of the gizzard, and of the intestinal tube generally, I have described in a note below *. The cloaca seemed to be formed much as in the ostrich, and to serve as a reservoir for the urine only; the rectum opening into it by a comparatively small orifice. The external opening of the oviduct in the Emeu of New Holland presented a circular range of membranous folds, which were wanting in the Indian Cassowary. In the latter, the hepatic canal is inserted along with the cystic and pancreatic ducts into a small bag, adhering to the intestinal canal, formed of the same tunics as the intestine itself. In the New Holland Cassowary, the hepatic and cystic ducts enter, as in the other, separately, but the small bag described above is wanting. The gall-bladder is wanting in the ostrich: the Galeated Cassowary has it of an oblong shape, and very large; it was quite filled with a dark green bile. In the New Holland Cassowary the gall-bladder is remarkable, both as to shape and strength. It is as it were divided into two portions; the parietes are strong and dense. The same may be said of the cystic duct, which bears no resemblance to the hepatic. The ducts conveying the bile from the liver to the gall-bladder enter by the fundus, and are very short. I am not aware of any physiological reason to account for these remarkable differences in birds so nearly resembling each other.

The heart of the Emeu of New Holland is more elongated than that of the Indian Cassowary; and some of its great arteries had undergone that change into semi-ossified plates, found so frequently in the arteries of the human subject, when aged. The Indian Cassowary has long been remarkable for the continuation of the cartilaginous rings of the bronchia into the lungs themselves,

* In the Indian Cassowary, the duodenum is very large, but contracts gradually to the insertion of the biliary ducts. From this point, the intestine continues to diminish in caliber, to within a few inches of the insertion of the cœca. It then rapidly, though not suddenly, increases to its final termination in the cloaca. In the New Holland Cassowary, the duodenum suddenly dilates into a considerable bag, and as suddenly contracts; the intestine continues to do so for about 16 inches, when it dilates on approaching the hepatic ducts. From this point, the intestine preserves a considerable uniformity of appearance, till it approaches the insertion of the cœca, when it rapidly increases to a very great diameter. The aperture by which the rectum communicates with the cloaca is of moderate size.

and for the existence of muscular fibres, after these have ceased. Both are also common to the New Holland Cassowary, whose trachea is much larger and longer than that of the Indian. In the former, likewise, at the fifty-second ring, counting from the glottis, there is found a large muscular bag, about the size of a man's head, into which the windpipe opens, by a large orifice, occasioned by a deficiency of a part of the circumference, in about thirteen tracheal rings; or rather, the rings, instead of closing around, to form the tube of the trachea, expand outwards, and are attached to the sides of the bag. This most remarkable, and, so far as I know, unique structure, attracted a good deal of my attention. It has no communication with any of the air-cells. I was at first at a loss to conjecture the use of this bag, and its importance to the animal; but reflecting on the nature of the country in which the emeu is found, it seemed to me extremely probable, that Nature, ever watchful of all her works, may have superadded this muscular appendage to the trachea of the New Holland Cassowary, to preserve it amidst those dangers, from sudden floods, to which New Holland is particularly exposed. The sandy plains of this extraordinary country are, during a great part of the year, inundated, and become then boundless marshes; and the plains generally are exposed to sudden inundations. The rivers, moreover, running westward from the great chain of mountains, terminate in vast muddy plains or inland marshes. The emeu, forced to seek his food amidst these fens, may, when obliged to have recourse to swimming, (which must very often be the case,) fill the muscular bag of the trachea with air, and thus convert it into a swimming-bladder. It may also assist the bird in escaping from his pursuers: but on this I mean not to insist, as the organ is wanting in the Galeated Cassowary, and in the ostrich; both remarkable for speed of foot. A moment's reflection must convince every one, that the bag can only be filled by the expiration of the bird, and that it cannot be dilated by inspiration; or, at least, it is excessively difficult to imagine how inspiration could be prolonged to such an extent, as to fill the air-cells of the body, the lungs, and muscular appendage of the trachea. On the other hand, the bird has only to employ the mechanism by which he forces the air into the air-cells and the osseous cavities, *i. e.* by closing the

glottis, and compressing the chest. On doing this, and calling into action the abdominal muscles, the air must of necessity be forcibly driven into the bag of the trachea; and may, by retaining the glottis shut, be alternately circulated between the lungs, air-cells, and bag of the trachea, giving the bird an additional advantage in running. It may not be altogether uninteresting to add, that the contents of the stomach shewed that these birds had been chiefly fed on animal fat.

EDINBURGH,
April 1823.

ART. XXII.—*Additional Observations on the Structure of the Trachea in the Cassowary Emeu of New Holland.* By Dr KNOX.

IN the preceding paper, I have detailed, at considerable length, the peculiarities in the internal structure of the Cassowary of New Holland, and of the Indian Emeu or Cassowary, describing, at the same time, though somewhat briefly, a very remarkable appendage of the trachea in the former bird, which had escaped the notice of preceding comparative anatomists. Since that time, frequent inquiries have been made, in relation to this peculiar structure; more particularly as to its nature, supposed functions and importance; but chiefly as to its analogies with the appendages found in the tracheæ of several other birds, of the duck and merganser kind. Now, these inquiries convinced me, that the subject had been viewed very incorrectly, even by those who were good anatomists, but who had not themselves examined the anatomy of the windpipe of birds, and had merely read accounts of the appendages sometimes connected with them; and this is the excuse I offer, for again recurring to this subject. I shall now briefly point out (what ought to have been done formerly) the total dissemblance between the appendage of the trachea in the Cassowary of New Holland, and those found in any other animal.

With a view to be better understood by those gentlemen who are not quite conversant with anatomical subjects, I shall refer to specimens of the trachea of the peacock, singing swan

(Anas Cygnus,) the golden-eyed duck *(Anas clangula,)* the Cassowary of India, and that of New Holland; of some of which I have caused accurate drawings to be made. In these, though diminished to about a sixth, the proportions have been strictly observed. It will be necessary, therefore, only to recall to the recollection a few elementary ideas, in order to place the subject in its true light.

In birds the trachea is, generally speaking, proportioned to the length of the neck, but to this there are some remarkable exceptions, the chief of which, as far as I have observed, is found in the *Anas Cygnus*, or wild swan. Moreover, in birds generally, the cartilaginous rings or circles of the trachea or bronchia (which in the trachea are complete), are found of equal diameter nearly throughout; but to this, also, there are some exceptions. Several present one or more dilatations in the course of one or other of these canals, and the actual diameter of the cartilaginous circles varies either gradually or suddenly. These peculiarities in structure are found chiefly in swimming birds, and one of the most remarkable is that which I now present to the Society. It would be difficult to decide on the precise use of these dilatations of the trachea in the swimming birds; but as they seem to be generally found in the male only, it is not improbable that they are connected with the organs of voice. But in the Cassowary of New Holland, the structure of the appendage of the trachea is altogether dissimilar to those described. It may be recollected, that in this bird the rings of the windpipe are complete, from their commencement at the upper larynx to about the fifty-second, when the next rings suddenly open by a wide aperture into a strong muscular bag, as large as the human head, closely attached to the sides of the trachea, and expanded rings. This bag is situated in the neck, immediately above the bone called Merry-thought: it was seen by me in the female, though it is probable that the male also possesses it. It is quite peculiar to the bird, no such appendage having been ever seen attached to the trachea of any of the feathered creation; nor do I know of any thing analogous to it in any other animal, excepting in the cameleon, to the upper portion of whose trachea there is appended a comparatively large membranous bag.

I stated in my former observations, that I believed it to per-

d, The dilatation found in the trachea of this bird, and formed simply by an increase in size of the natural rings of the trachea.

e, A remarkable osseous dilatation found at the division of the trachea into the bronchial tubes.

It has not been thought necessary to give a representation of the windpipe in the *singing swan;* the peculiarity in the trachea of that bird consisting not in any dilatation of its caliber, but a great increase in length, beyond the actual measurement of the neck. It has been often described by authors.

Art. XXIII.—*On the Series of Crystallisation of Apatite.* By William Haidinger, Esq.

Most of the mineralogical systems of the present day, perhaps that of Werner only excepted, agree in a perfectly correct determination of the species of Apatite. In the system of Professor Mohs, it forms with Fluor-Spar a particular genus of the order Haloide; and agreeably to this arrangement, apatite is termed the *rhombohedral*, whilst fluor-spar receives the denomination of the *octahedral fluor-haloide.* When first introduced to the notice of mineralogists, it gave rise to a great contrariety of opinions. Unfortunately, the name of Chrysolite, given by German mineralogists to the species of prismatic chrysolite of Mohs, had been applied by the French to the asparagus-green varieties of rhombohedral fluor-haloide from Spain, the Spargelstein of Werner; and the great confusion produced by this double employment of the same name had not ceased before that of chrysolite had entirely been expunged from the French mineralogy, and in the German, finally given to that species which is denominated Peridot by Haüy. One of the varieties of apatite, found at Johanngeorgenstadt in Saxony, was, for a long time, exhibited among the varieties of precious beryl; afterwards it was called Agustite, when, by some imperfect analysis, it was supposed to contain a particular kind of earth, the agust-earth, so called, on account of the property of forming insipid compounds with several acids, which substance, however, subse-

Fig. 5

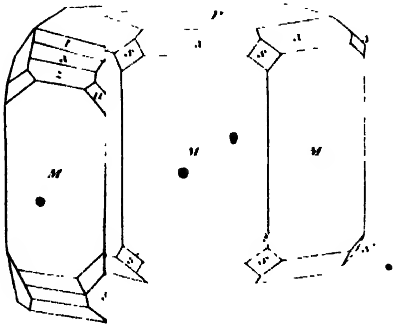
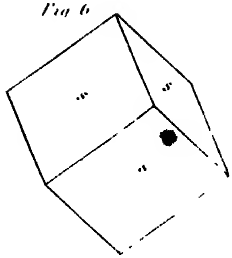


Fig. 6



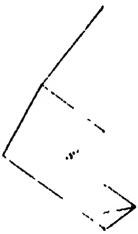


Fig. 11

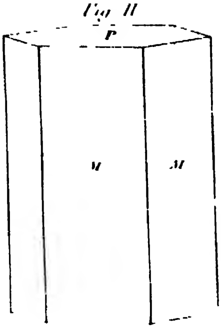
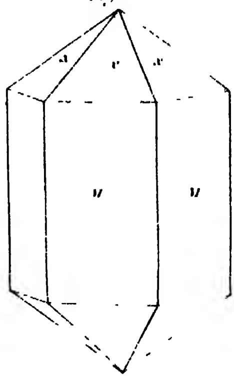


Fig. 13



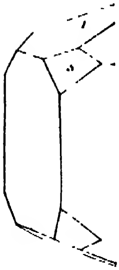


Fig. 19

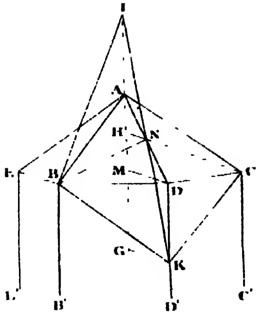
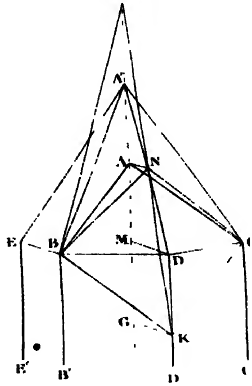
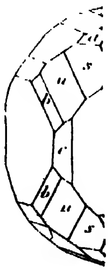


Fig. 20





quently turned out to be Phosphate of Lime. Being not at all a rare substance, although it commonly occurs but in small quantities, it could not fail frequently to introduce itself to the attention of mineralogists, but it cannot be considered as having been an established species, before Klaproth discovered its chemical nature, and Werner named it Apatite, the *Deceiver* (from *ἀπατάω*,) as a species, that had so long deceived naturalists. Haüy ascertained the identity of the Spanish and the Saxon varieties, still considered by Werner as distinct species, under the names of Asparagus-stone, and Apatite, the number of which he still increased by a third, the Phosphorite, which comprehends the earthy varieties of rhombohedral Fluor-haloide.

But whatever opinions may have prevailed on the subject of the determination of the species, its crystallisations, at least, have always been correctly described, in as far as refers to the system of crystallisation; its forms having, in every instance, been traced to the regular hexagonal prism. Many mineral species have been less fortunate. It might almost be quoted as a prominent character of the earlier period of crystallographic science, that, whilst the forms were frequently supposed more regular than they afterwards proved to be, the small additional facets were almost entirely neglected. By many they were considered as accidental modifications of those forms, which take the greater share in determining the general aspect of the crystals, and which, as mere modifications, do not tend to confer any thing towards a more accurate knowledge of the species; by others they were entirely overlooked, or, on the other hand, completed according to some prepossession, in favour of the greatest regularity that possibly could be introduced, in representing the forms of the species. The last was the case, when Haüy undertook to describe those inclined faces of the crystals of apatite, which do not produce any horizontal edges of combination with those of either of the two regular six-sided prisms. These inclined faces are contained in his *Variété doublante* from St Gothard, which he describes in the Tableau Comparatif, and gives a representation, of which Fig. 1 Pl. V. is an exact copy. In that variety, the faces *u*, belonging to a scalene six-sided pyramid, derived from R (*s*), are said to appear by pairs contiguous to each of the angles produced by the faces 2(R) and $P+\infty$ (*s* and *M*). This, however, does

not take place in reality. The combination of the same forms, as produced by Nature, is that in Fig. 2., where those faces of *u*, which are inclined towards the upper extremity of the crystal, appear only at the left, those which are inclined towards the lower one, if the crystal be inverted, only appear at the right hand edges of combination between 2(R) and P+∞. Among all those mineral species, whose forms belong to the rhombohedral system, there is only one, which, in some respect, may be compared to the species of apatite, as exhibiting a peculiarly remarkable character in the combinations containing the faces of scalene six-sided pyramids. The varieties here alluded to are those of rhombohedral quartz, called *plagièdre*, *coordonné*, &c. by Haüy, which, a long time since, have fixed the attention of naturalists, and lately received an additional degree of interest, by the recent discovery of the exact agreement between this external form, and the phenomena of the circular polarisation, as demonstrated by Herschel. Yet there is one striking difference between the two species, in the mode in which the opposite extremities of their crystals are terminated; in quartz, notwithstanding the crystal may be inverted, yet, on the opposite end, the inclined faces of the scalene pyramids will continue to appear at the same side of the faces of R: on both ends the right, or on both ends the left. In apatite, the right hand faces, contiguous to one of the extremities, co-exist with the left hand ones of the other; and hence there is no such difference of *right* or *left individuals*, as in the other species. This difference appears perfectly evident, in comparing the variety of apatite in Fig. 2., with those of quartz in Fig. 3. and Fig. 4., the former of these being a right, the latter a left individual. If all these inclined faces be duly enlarged, till they intersect each other, and limit the space by themselves, they produce in apatite a form, which, but for its position in respect to other forms of the series, might be called an isosceles six-sided pyramid, whilst the result of this enlargement of the faces in quartz would be solids contained under twelve, or if they appear only at the alternating angles of the common combination, under six trapezoidal faces, which solids, even by themselves, continue to shew that relation between right and left, in which they appear in the combinations. The varieties of apatite, in which I first remarked this singular configuration of the crys-

tals, were those from Schlaggenwald in Bohemia. I have since had the opportunity of examining a great number of crystals from different localities, which uniformly exhibited the same appearance.

The forms of apatite belong to the rhombohedral system of Professor Mohs. The character of their combinations is di-rhombohedral; that is to say, the combinations contain the faces of the rhombohedrons in both, the parallel and the turned position, whenever one of them is met with in a compound form. Thus, in Fig. 5., the faces *s*, *s*, &c. belong to R, the fundamental rhombohedron of the species, Fig. 6.; whilst *s′*, *s′*, &c. if duly enlarged, till they limit the space by themselves, will produce, Fig. 7., a rhombohedron of exactly the same dimensions, only in a position 60° different from that of R. Of the other forms contained in the combination P, being the plane perpendicular to the principal or rhombohedral axis, is evidently $R-\infty$, or the limit on one side of the series of rhombohedrons.

Many persons, not sufficiently acquainted with every part of the system of crystallography of M. Mohs, have found fault with the signs dependent, like that of $R-\infty$, upon the idea of infinity. Thus, Mr Brooke says, in his Introduction to Crystallography, that "the consideration of infinite lines, which M. Mohs has introduced into his system, and his notation founded on this character, are parts of his theory which will probably render its public reception less general than it might have been, from its merits in other respects." In order to enable the reader to form an opinion in this matter, I shall subjoin a few explanatory remarks, in respect to that idea of infinity, as introduced by M. Mohs; and this cannot be done more satisfactorily, than by developing the principle upon which it is founded.

If we suppose, Fig. 8., tangent planes, equally inclined to both the adjacent faces of a rhombohedron, to be applied to the terminal edges of that form, and these planes to be enlarged, till they intersect each other, they will produce a new rhombohedron, which is more obtuse than the given one. The axis AX is common to both the forms, the side of the horizontal projection OR, of the more obtuse, is equal to 2 O′ R′, or double the side of the horizontal projection of the more acute rhombohedron;

and if the more obtuse rhombohedron is so much diminished in size, till the horizontal projections of the two forms are equal, the axis of the latter will be one-half of the axes of the former. The same process of laying tangent planes into the terminal edges, applied to the more obtuse rhombohedron of the two, produces another still more obtuse; this rhombohedron a fourth, and so on. If the axis of the fundamental rhombohedron is $= a$, that of the first derived will be $\frac{1}{2} a$, of the second $\frac{1}{4} a$; a, $\frac{1}{2} a$, $\frac{1}{4} a$, being three members of a series, which continued on both sides, can be represented thus:

$$----\tfrac{1}{8}.a,\ \tfrac{1}{4}.a,\ \tfrac{1}{2}.a,\ 1.a,\ 2.a,\ 4.a,\ 8.a----$$

The ratio of the axis in this series, therefore, is that of

$$----2^{-3},\ 2^{-2},\ 2^{-1},\ 2^{0},\ 2^{1},\ 2^{2},\ 2^{3}----$$

that is to say, the series proceeds according to the powers of the number 2.

In the method of crystallographic designation of M. Mohs, the letter R is used for denoting the fundamental rhombohedron, whose axis is $= a$. Every derived rhombohedron of the series is expressed by the same letter, to which is added that exponent of the power of 2, which indicates the place of the member in the series, so that the fragment of the series given above, will be represented by the following succession of crystallographic signs:

$$----R-3,\ R-2,\ R-1,\ R,\ R+1,\ R+2,\ R+3,----$$

The very idea of a series leads to the inquiry about what will be its limits. In the series of rhombohedrons it is evident that the limits cannot be attained, till the axis of one of its members becomes $= 0$, or $= \infty$; for every finite quantity, whether great or small, can be multiplied or divided by 2; but it is impossible to go beyond the values of 0 or ∞. In order to obtain 0 for the value of the axis in a member of the series of rhombohedrons, a, the axis of R, must be multiplied with $2^{-\infty}$; and in order to obtain ∞, the same a must be multiplied by 2^{∞}. The respective signs of the two limits will therefore be $R-\infty$, and $R+\infty$, and those of the series of rhombohedrons between its limits:

$$R-\infty\ ---\ R-2,\ R-1,\ R,\ R+1,\ R+2,\ ----\ R+\infty.$$

The horizontal projection of all the members of the series is one and the same regular hexagon; so is also the section perpendicular to their axes. $R-\infty$ having the same figure, but an in-

finitely small axis, is represented by a single plane perpendicular to the axis of R; whilst R+∞, which has the same transverse section as R, but an infinite axis, will have its faces disposed parallel to the direction of the same line, and, therefore, in no respect differ from a regular six-sided prism. On account of the identity of the transverse sections, R+∞ is that regular six-sided prism, which produces horizontal edges of combination with any rhombohedron of the series.

From the preceding development we may conclude, that, contrary to Mr Brooke's assertion, the idea of infinity (which certainly is not a consideration of infinite lines) thus introduced, would be particularly recommendable in the method of M. Mohs, both for the elegance in the expression, and for the simplicity which it imparts to the method altogether. I am so much convinced of the extensive crystallographic knowledge displayed by the author of the preceding quotation, that I do not doubt he will perfectly concur in the latter opinion, when the system of M. Mohs shall have been sufficiently developed to the public, "to enable him to judge fairly of its merits."

But let us return to the further development of the combination. The faces x, x, &c. if they limit a space by themselves, form an isosceles six-sided pyramid. On account of the parallelism of its terminal edges with those in which it intersects the faces of R, x is the isosceles pyramid belonging to that rhombohedron, and P therefore is its crystallographic sign. The faces of M, lastly, are the limits of the series of isosceles six-sided pyramids, or the isosceles six-sided pyramid belonging to R+∞, and as such designated by P+∞. The designation of the whole form therefore is,

$$\begin{array}{cccc} R-\infty. & P. & 2(R). & P+\infty. \\ P & a & s,\ s' & M \end{array}$$

The measures of the angles relative to the simple forms contained in this combination are the following. The angle at the terminal edges of R is = 88° 41′. R (fig. 6.) is obtained, as mentioned above, by enlarging the faces s, s, s, &c. The side of its horizontal projection being supposed = 1, the length of

the axis, or a, is expressed by $\sqrt{4.824}$ *, a quantity derived from measurements with the reflective goniometer. The combination of R with itself in a turned position, or 2 (R), assumes the appearance of an isosceles six-sided pyramid (fig. 9.), from which, however, it differs by its relative position to other forms of the series. Its terminal edges x, x, &c. are = 131° 14′; the lateral z, z, &c. = 111° 20′ †. In the pyramid P (fig. 10.), denoted in the figure by the letter x, the value of the angles is the following: x, x, &c. = 142° 20′; z, z, &c. = 80° 25′ ‡. It is almost needless to remark, that the angle produced by two faces of P+∞ (*M*) is = 120°, and that R—∞ (*P*) intersects at right angles any one of the faces of P+∞.

I shall not endeavour to give here a full description of all those crystalline varieties of the species, which either have been described by several authors, or which I have had myself an opportunity of examining; but it may be interesting to retrace as many of them as will suffice for exhibiting a correct and pretty perfect general view of the series of crystallisation of rhombohedral fluor-haloide, and of those peculiarities by which it is distinguished from the rhombohedral forms of other minerals.

One of the most simple varieties to be found among the crystals of rhombohedral fluor-haloide, is the combination of R—∞ (*P*) with P+∞ (*M*) fig. 11., or the regular six-sided prism, terminated by a plane perpendicular to its axis. It occurs in the apatite from Devonshire, from Saxony, and from other places. It is the only crystalline form of the asparagus-stone from Salzburg; and it may here be observed, that the distinctive character, which some mineralogists have endeavoured to introduce between apatite and asparagus-stone, founded upon the presence or the want of this face of R—∞, has no foundation in nature.

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* The axis of the rhombohedron being = a, the formula for finding the terminal edge x is $\cos x = \frac{2a^2-9}{4a^2+9}$.

† According to the formulæ for the dirhombohedron, a being the axis of the simple rhombohedron : $\cos x = -\left(\frac{2a^2+9}{4a^2+9}\right)$; $\cos z = -\left(\frac{4a^2-9}{4a^2+9}\right)$.

‡ According to the formulæ for the isosceles six-sided pyramid, a being the axis of that rhombohedron, to which the pyramid belongs :
$\cos x = -\left(\frac{2a^2+27}{4a^2+27}\right)$; $\cos z = -\left(\frac{4a^2-27}{4a^2+27}\right)$.

The observed varieties with R—∞ in asparagus-stone, and others like fig. 12., without it, in the apatite from Ehrenfriedersdorf in Saxony, although not of a general occurrence, are sufficient to remove this last supposed difference: the combination in fig. 12. is P—1. 2(R). P+∞; the angles of P—1 = 157° 33′; 45° 49′.

The crystalline forms occurring in asparagus-stone, both of the asparagus green varieties from the Cabo de Gata, and of the dark bluish-green from Arendal, in Norway, the latter of which have also been called Moroxite, are generally very simple; in most cases, the combinations P. P+∞, and P. R+∞. P+∞, represented in figs. 13. and 14. The surface of these crystals is commonly very smooth and even, sometimes the edges are rounded, particularly in the varieties from Arendal.

Among the numerous varieties found in the mines near Ehrenfriedersdorf, in Saxony, one most deserving our attention is that represented in Fig. 15., of which the original may be seen in the collection of Dr Rohatsch at Freyberg. Besides the limits of the series of rhombohedrons and isosceles six-sided pyramids, R—∞ (*P*) R+∞ (*e*) and P+∞ (*M*), it contains three dirhombohedrons *a*, *s*, and *d*, and three isosceles six-sided pyramids, *r*, *x* and *z*; the relations of which to one another it will be easy to find from the observed parallelism of their edges of combination. From the preceding combinations, particularly Fig. 5., *s* is known to be 2 (R), and *x* to be P, or that isosceles six-sided pyramid, whose terminal edges are inclined to the principal axis under the same angle, as those of the rhombohedron R, produced by enlarging the alternating faces marked *s* in the figure. The edges of combination between *s* and *x* are parallel to the terminal edges of both these forms. The faces of the dirhombohedron *a* appear with parallel edges of combination in the place of the terminal edges of the pyramid *x*, they would hence likewise produce parallel edges of combination, if applied to the terminal edges of the rhombohedron R, and the whole form produced by enlarging all the faces marked *a*, will consequently be 2 (R—1), its angles * = 145° 38′; 72° 25′. The edges of combination

* According to the formulæ for the dirhombohedron, quoted above, only $\frac{a}{2}$ must be substituted for *a*.

between a and r, are parallel to the terminal edges of r, hence the latter is the scalene sid-sided pyramid belonging to $R-1$, that is to say $P-1$. The axis of this pyramid is equal to one-half of the axis of P, and the angles, as given above for the variety Fig. 12. In the same way in which r and a, and x and s are co-ordinate members of the two series of six-sided pyramids, and of the rhombohedrons to which they belong, so likewise z and d belong together, being $P+1$, and $2(R+1)$, as the consideration of the figure will sufficiently prove. The angles of $P+1$ (z) are $=129° 1'$; $118° 48'$, those of $2(R+1)$ (d) $=123° 31'$; $142° 18'$. The faces perpendicular or inclined to the axis are very smooth and splendent; those which are parallel to it, commonly bear more or less deep striæ. The intersections of the different forms with each other cannot, in every instance, be observed at one and the same angle, and it is here as in so many other cases, that the practised eye of the crystallographer must supply the accidental deficiencies, owing to the irregular formation of crystals.

Very interesting varieties of forms are met with among the white transparent crystals from St Gothard, as, for instance, those in Figs. 16. and 17. They exhibit, most distinctly pronounced, the faces of the scalene six-sided pyramids belonging to R, marked in the figures with the letters u and b. They moreover contain faces of the limits of the series of these forms, unequiangular twelve-sided prisms, which likewise partake in the remarkable property that they enter into the combinations with only half the number of their faces. A very beautiful specimen, containing both the pyramids, u and b, is in the excellent collection of Mr Allan.

The crystallographic problem to be resolved in respect to the varieties represented, is, from the observed parallelism of the edges of combination, to find the geometrical relations of the simple forms towards each other, and to express these forms themselves by their crystallographic signs.

From the preceding combinations, we know P to be $=R-\infty$, $r=P-1$, $a=2(R-1)$, $x=P$, $s=2(R)$, $z=P+1$, $M=P+\infty$, and $e=R+\infty$; the forms to be determined are therefore only those marked u, and b, whose general expression is $(P+n)^m$; and those marked c and f, expressed in a general

manner by $(P+\infty)^m$, inasmuch as the latter are limits of the series of the pyramids themselves.

According to the derivation employed in the crystallographic method of Professor Mohs, a scalene six-sided pyramid is obtained from a rhombohedron, by lengthening the axis of the latter on both sides to an indefinite but equal length, and joining the terminal points of the axis thus determined, and the lateral angles of the rhombohedron, by straight lines, as in Fig. 16. The number m expresses the ratio of the lengthened axis A′X′, to the original one A X. Two forms, a rhombohedron, and a scalene six-sided pyramid thus connected with each other, are considered as co-ordinate members, or such as belong together in their respective series.

The edges of combination between *s* and *u* are parallel to the lateral edges of R; so are those between *s* and *b*. Both the pyramids, therefore, belong to R, and their general sign, n being equal $=0$, becomes $(P)^m$, where the exponent m is still to be determined.

The situation of *u* is exactly determined by the parallelism of the edges of combination between *x* and *u*, and those between *u* and *e*. Suppose in Fig. 19., AEB, ABD, ADC to be three faces of the isosceles six-sided pyramid P, ABKC one of the faces of the rhombohedron R. If a face of the scalene pyramid in question passes through the point B, its intersection with ABKC will coincide with the edge BK, the latter being the edge of combination between the faces of R and $P+\infty$; but the line BN, its intersection with ABD, will bisect the terminal edge AD of the pyramid P in the point N, because B′BNCC′ denotes the direction of one of the faces of $R+\infty$ (*e*), passing through the point B. The line KI, which joins the lower angle K of the rhombohedron R, with the angle of combination N, determines the situation of I, the apex of the required pyramid, one of whose faces, therefore, is the triangle IBK. The axis of the derived pyramid is $=2\,AI+\frac{3}{2}\,AG$, AG being $=\frac{2}{3}$ of the axis of R, and AI the prolongation of the axis on one side of the rhombohedron, analogous to AA′ in Fig. 18. Now,

$$IA+AH : HN = IA+AG : GK,$$

and a being the axis of R,

$$IA+\tfrac{1}{6}\,a : \tfrac{1}{2} = IA+\tfrac{2}{3}\,a : 1$$

Hence $IA = \frac{1}{3}a$, and the axis of the pyramid, being $= \frac{2}{3}a + a$, is $= \frac{5}{3}a$. The exponent m is therefore $\frac{5}{3}$, and the original sign for the pyramid $= (P)^{\frac{5}{3}}$, which, on account of the peculiar character of the combinations, still must undergo a farther modification.

The pyramid b is determined by the parallelism of the edges of combination between s and b, and between b and M. In Fig. 20., as in the preceding, ABKC is one of the faces of R, but A′EB, A′BD, and A′DC, are three faces of $P+1$, and not of P, because in this consists the difference between the two cases. The axis of the derived pyramid is equal to $2\,IA + \frac{3}{2}$ AG. In order to find IA, we have

$$IA : AN = IA + AG : GK,$$

and, a being the axis of R,

$$IA : \tfrac{1}{2} = IA + \tfrac{2}{3}a : 1\,.$$

Hence $IA = \frac{2}{3}a$, and the axis of the pyramid $= \frac{7}{3}a$. The original sign of the pyramid becomes therefore $(P)^{\frac{7}{3}}$.

The signs $(P)^{\frac{5}{3}}$ and $(P)^{\frac{7}{3}}$, although they in general denote the direction of the faces, yet do not suffice for expressing that mode in which they are contained in the combinations of the species. According to the method of Professor Mohs, the sign of a dirhombohedron in general is $2\,(R+n)$, that of s is $2\,(R)$; in a like manner the dipyramids are in general designated by $2\left((P+n)^m\right)$. Supposing, in the developed combination, all the faces of the pyramids to appear, these signs would become, $2\left((P)^{\frac{5}{3}}\right)$ and $2\left((P)^{\frac{7}{3}}\right)$. But there are only the alternating faces to be observed in the combinations, and the way to denote the pyramids, including the situation of their faces to the right or the left of the faces of R, will therefore be: $\frac{l}{r}\,\frac{2\left((P)^{\frac{5}{3}}\right)}{2}$, and $\frac{l}{r}\,\frac{2\left((P)^{\frac{5}{3}}\right)}{2}$, as referring to the figures. The addition of the letters r (right), and l (left), is required for distinguishing the combinations occurring in apatite, from those which are to be met with in quartz, where, in different individuals, we have to express by $\frac{r}{r}\,\frac{2\left((P)^{\frac{7}{3}}\right)}{2}$ (Fig. 3.) and $\frac{l}{r}\,\frac{2\left((P)^{\frac{7}{3}}\right)}{2}$ (Fig. 4.), that

in these combinations contiguous to both the apices, only the right, or only the left faces of the scalene six-sided pyramids can be observed. The inclination of u to M is $=150° 40.5'$, that of b to $M = 157° 26'$; this inclination being equal to the sum of one-half of the angle at the lateral edge of $(P+n)^m$, and 90° *.

As to the twelve-sided prisms, it is evident, from the horizontal edges of combination between u and c, that the latter is the limit of that very same series of which the former is a member. Since it does not appear with the full number of its faces, but only with those which, considered from one extremity of the crystal, appears on the left, from the other on the right of the faces of R, its representative sign will be $\frac{l}{r}\,\frac{(P+\infty)^{\frac{5}{3}}}{2}$.

For the want of appropriate edges of combination, I have been obliged to resort to immediate measurement for ascertaining the position of the faces, marked f, and the law, by which the form produced by these faces depends upon the fundamental rhombohedron R. The prism in question is the limit of that series of six-sided pyramids, whose derivative exponent is the number 3. The sign of these faces as they appear in the combination, to the right of R on the one side, and to its left on the other, will therefore be $\frac{r}{l}\,\frac{(P+\infty)^3}{2}$.

The angles of the transverse section of the two twelve-sided prisms are the following:

	Angle y, contiguous to the faces of 2(R), or of R + ∞ (c).	Angle z, contiguous to the terminal edges of 2 (R), or to the faces of P + ∞ (*M*).
$(P+\infty)^{\frac{5}{3}}$	158° 12′ 48″	141° 47′ 12″
$(P+\infty)^3$	141° 47′ 12″	158° 12′ 48″

* The lateral edge z Fig. 16., is obtained by the formula,

$$\cos z = -\left(\frac{(3m^2-1)\cdot a^2 - 9}{(3m^2+1)\,a^2+9}\right).$$

a being the axis of the rhombohedron, and m the exponent or number of derivation upon which the pyramid depends.

The transverse sections of the two prisms are therefore equal to each other as to the measure of their angles, but they differ in the relative situation of their more acute and more obtuse edges. In the combination, Fig. 16., which, besides R + ∞ (*c*), and P + ∞ (*M*), contains the faces of $(P + \infty)^{\frac{5}{3}}$ (*c*) situated to the left, and those of $(P + \infty)^{3}$ (*f*) situated to the right of the faces of R + ∞, the transverse section is a figure of twenty-four sides, the angles of which are alternately 169° 6′ 24″, and 160° 53′ 36″.

If in Fig. 18. the more acute terminal edge of the scalene six-sided pyramid is called x, the more obtuse one y, the lateral edge z; and we suppose the axis of the rhombohedron to become infinite, the pyramid is transformed into a twelve-sided prism, of which the alternating angles are equal. The edge y becomes vertical, and appears in the combinations contiguous to the faces of R + ∞ (*e*), the edge z also becomes vertical, and appears contiguous to the faces of P + ∞ (*M*), exactly as is mentioned in the preceding Table. The reversed equality of the angles in two different prisms, as given in this Table, depends, therefore, upon that of the geometrical expressions for these two edges.

The general expression for the edge y is

$$\cos y = -\left(\frac{(3m^2 + 6m - 1)\, a^2 + 18}{2[(3m^2 + 1)\, a^2 + 9)]}\right),$$

that for the edge z,

$$\cos z = -\left(\frac{(3m^2 - 1)\, a^2 - 9}{(3m^2 + 1)\, a^2 + 9}\right);$$

a being the axis of the rhombohedron, to which the pyramid belongs, and *m* the number of derivation, or that which expresses the ratio between the axes of the two forms.

If now, *a* being infinite, cos y of $(P + \infty)^m$ is supposed = cos z′ of $(P + \infty)^{m'}$, for a certain *m* in the first, and another *m′* in the second expression, we obtain

$$\frac{3m^2 + 6m - 1}{2\,(3m^2 + 1)} = \frac{3m'^2 - 1}{3m'^2 + 1}, \text{ and}$$

$$m'^2 = \frac{1 + 6m + 9m^2}{9(m^2 - 2m + 1)}, \text{ or } m' = \frac{1 + 3m}{3\,(m - 1)}, \text{ and}$$

from the last, $m = \dfrac{1 + 3m'}{3(m' - 1)}$.

If, in these formulæ instead of m, we substitute $\frac{5}{3}$, the value of m' becomes 3, and *vice versa;* so that, in fact, the two numbers of derivation $\frac{5}{3}$ and 3 will yield twelve-sided prisms, whose alternating angles are inversely equal to each other.

The substitution of $\frac{7}{3}$, the number of derivation of the other pyramid, in these formulæ, instead of m, would make $m' = 2$.

Numerous very interesting results might still be obtained from a further continued comparison of the forms occurring in the crystals of apatite, and in those of other species which belong to the rhombohedral system. Among these I shall only mention, that the scalene six-sided pyramids, derived according to the numbers $\frac{5}{3}$ and $\frac{7}{3}$, are far less generally to be met with in nature than those dependent upon the numbers 3 and 2. Yet they have already been observed in several species, for instance $(P)^{\frac{7}{3}}$ in rhombohedral quartz, being the pyramid noted *x* in Haüy's Figures, and in Figs. 3. and 4. of the present paper, $(P)^{\frac{5}{3}}$, and $(P+1)^{\frac{5}{3}}$ in calcareous-spar, &c. whilst the peculiar character of the combinations of apatite, in as far as our present knowledge reaches, is quite unparalleled in the Rhombohedral System, in which it stands as isolated, and as remarkable as the series of crystallisation of rhombohedral quartz.

There exists a striking analogy between the forms of Apatite in the rhombohedral, and those of Tungstate of Lime, (Pyramidal Scheelium-baryte) in the pyramidal system. A more detailed examination of this analogy, how interesting soever it might prove, is a subject which requires so many particulars, that it will be better to defer it to some future occasion.

ART. XXIV.—*Account of some remarkable and newly discovered Properties of the Suboxide of Platina, the Oxide of the Sulphuret, and the Metallic Powder of Platina.* By Prof. DÖBEREINER of Jena *.

MR EDMUND DAVY had shewn, in 1820, that sulphate of platina, if boiled in alcohol, and subsequently digested in am-

* Translated and abridged from the original paper, published in Gilbert's *Annalen der Physik*, which Professor Gilbert has been so kind as to transmit to us previous to its publication in his valuable Journal.—ED.

monia, leaves a suboxide of platina, containing only $\frac{1}{8}$th per cent. of oxygen, and that suboxide has the property of being reduced with detonation into the metallic state, if brought in contact with a small portion of alcohol. It is some time since I have shewn, in the *Annalen der Physik*, that this detonating platina disposes the alcohol to attract oxygen, by which it is converted into a mixture of acetic acid and water. I have since found the same property in the oxide of sulphuret of platina, which is obtained by exposing the dry sulphuret of platina for several weeks to the influence of the atmosphere. In this remarkable change, 1 atom of alcohol ($= 46$) attracts 4 atoms of oxygen ($= 4 \times 8 = 32$), and forms thus 1 atom of acetic acid ($= 51$) and 3 atoms of water ($= 3 \times 9 = 27$). The relative quantity of water and acetic acid is here exactly the same as in crystallised acetate of lead (*Saccharum saturni*) and in the subacetate of copper. In the acetate of soda the quantity of the water is double that of either of these salts.

During the last winter, I tried a number of experiments relative to the action of the two preparations of platina upon several expansible bodies, of which the following are the most remarkable.

The suboxide of platina and the oxide of the sulphuret of platina do not absorb either oxygen or carbonic acid gas, but they absorb whatever combustible gas is brought into contact with them. One hundred grains of the suboxide of platina absorb from 15 to 20 cubic inches of hydrogen gas; and during this process, so great a quantity of heat is developed, that the metallic substance becomes red-hot, and the hydrogen gas detonates, if previously mixed with atmospheric air, or with oxygen gas.

The platina thus charged with hydrogen greedily absorbs a portion of oxygen, as much as will suffice for the formation of water; if brought in contact with less than the portion of atmospheric air required for this purpose, the hydrogen combines with part of the azote, and forms ammonia. During this process the platina is perfectly reduced to a metallic state, and loses the property of decomposing alcohol; but it retains that of disposing a mixture of oxygen and hydrogen to combine and form water, which is attended with an incandescence of the platina, if

the two gaseous substances have been pure, and not applied in too small quantities.

By this highly remarkable phenomenon I was led to suppose that the same would take place in the powder of metallic platina, obtained by decomposing the muriate of platina and ammonia by the application of heat. I wrapped up a portion of the powder of platina into white blotting paper, and surrounded it with an atmosphere of hydrogen gas; neither an absorption of the gas, nor any other change, was perceptible. I now added to these substances a portion of atmospheric air. In a very short time the substances began to act upon each other, and after ten minutes all the oxygen contained in the atmospheric air had combined itself with a portion of the hydrogen gas, and formed water *. The result was the same, when, instead of atmospheric air, I introduced pure oxygen gas; only it was obtained in a shorter space of time, and the heat produced was sufficient to reduce the paper into cinders.

I consider this phenomenon to be produced by an electrical chain, consisting of only two substances, one solid, viz. platina, the other expansible, viz. hydrogen; the latter of them standing in the place of zinc in the Voltaic pile.

Another remarkable phenomenon is, that oxide of carbon, if brought in contact with oxide of the sulphuret of platina, is reduced to half its former volume, and changed, at the same time, into carbonic acid gas. During this process part of the carbon is absorbed.

Jena, April 4. 1823.—I have now succeeded in finding out a beautiful experiment for exhibiting the action of powder of platina upon hydrogen gas. Put the powder of platina † into a glass-funnel, shut at its lower extremity. Introduce from above a current of hydrogen gas through a capillary tube, the end of which must be distant from one to two inches from the platina, in order to have the hydrogen gas mixed with atmospheric air, before it comes into the contact with the metal. The dust of

* The affinity of oxygen and hydrogen is so much heightened by their contact with platina dust, that a mixture of 99 parts of azote, and 1 part of oxygen, can in a few minutes be deprived of the latter,—an effect which cannot even be produced by an electric spark.

† M. Dœbereiner has since found that 5 grains of platina is sufficient for this experiment.

platina almost instantaneously becomes first red, then white-hot, and continues in this state as long as there is any hydrogen gas acting upon it. If introduced in a quantity sufficiently considerable, the gas itself will be inflamed.

Since the preceding paper was written, M. Dobereiner has endeavoured to deduce a eudiometrical process from this singular property of platina *. He mixes the pulverised platinum with a little clay, and having formed it into a mass of the consistency of paste, he converts it into small balls of the size of a pea. He then dries them, and makes them red-hot with the blowpipe, in order to give them solidity. He now introduces one of these balls into a tube of glass, shut up above, and resting on a trough of mercury, and containing two volumes of hydrogen gas and one of oxygen. The mixture of these two gases forms water in a few seconds. One of these balls may serve for a hundred experiments, provided it is dried in the air after each experiment.

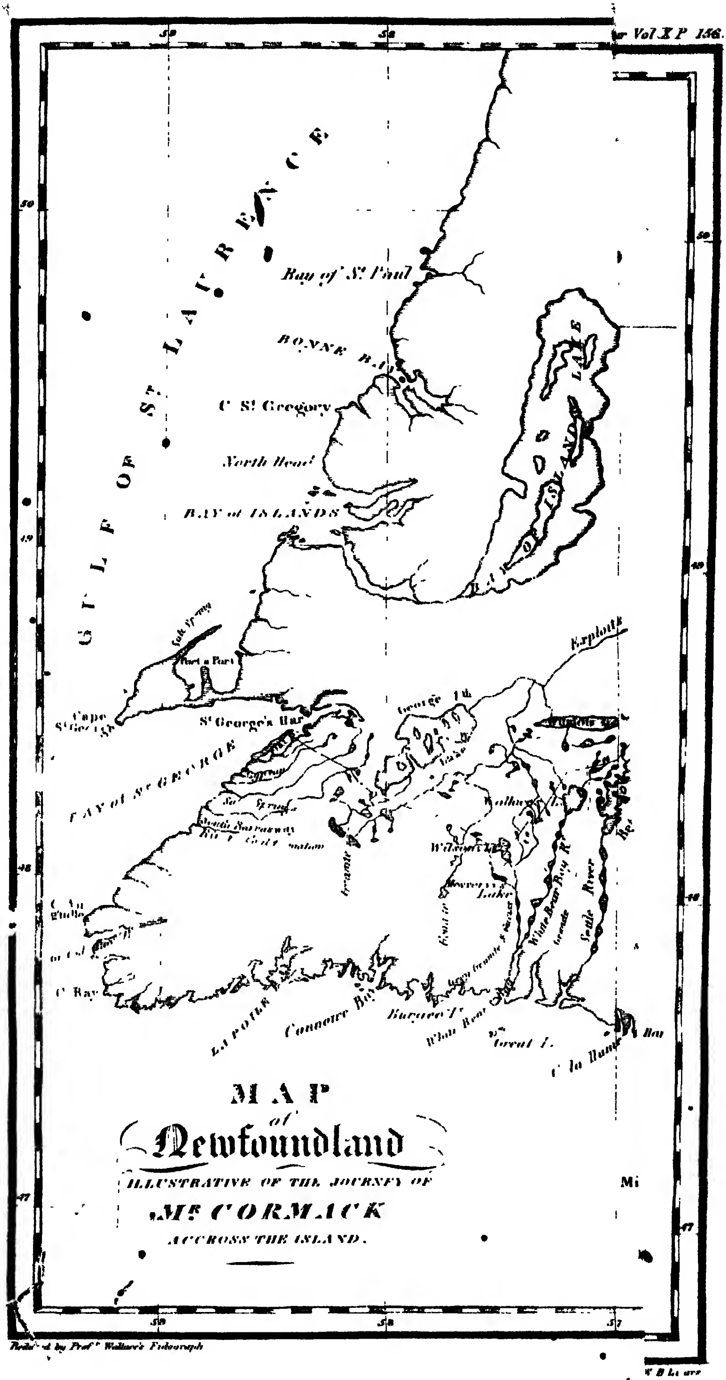
Art. XXV.—*Account of a Journey across the Island of Newfoundland*, by W. E. Cormack, Esq. In a Letter addressed to the Right Hon. Earl Bathurst, Secretary of State for the Colonies, &c. &c.—with a Map of Mr Cormack's Journey across the Island of Newfoundland †.

My Lord,

In the beginning of September 1822 I left Smith's Sound, at Random Island, accompanied only by one Micmac Indian; and

* We understand that Mr Faraday has found that palladium possesses the same property as platina.

† My enterprising young friend Mr Cormack having communicated to me some notices of his journey across Newfoundland, I transmitted the same to Lord Bathurst, through John Barrow, Esq. Secretary of the Admiralty. His Lordship, in acknowledging Mr Barrow's communication, says, that the journey through the interior of Newfoundland, is, he believes, with one exception, the only one in which the island had been crossed;—that the state of the Red Indians had attracted his Lordship's attention many years ago, as there was reason to believe that our people had put them to death without sufficient provocation; hence there is no wonder that they fly from all approachers; that it is not improbable that the Micmac Indians may have contributed to this indisposition to accept the advances which have been made them; that Mr Cormack's attempts to conciliate them could not be otherwise than interesting; and that the publication of the notice of the journey has his Lordship's sanction and approbation.—R. J.



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GULF OF ST. LAURENCE
Bay of St. Paul
BONNE BAY
C. St. Gregory
North Head
BAY of ISLANDS
LAKE OF ISLANDS
Salt Springs
Port a Port
Cape St. George
St. George's Bay
BAY of St. GEORGE
Exploits
George 4th Lake
Wallace's L.
Wilson's L.
Meeveen's Lake
White Bear Bay R.
Gander River
Connoire Bay
Bargace I.
White Bear
Great I.
C. la Hune
Bay
LA POILE
C. Bay
MAP
of
Newfoundland
ILLUSTRATIVE OF THE JOURNEY OF
Mr. CORMACK
ACCROSS THE ISLAND.
Reduced by Prof. Wallace's Eidograph

accompanied by two of that tribe, reached St George's Harbour in the beginning of November. I encountered more impediments in accomplishing the undertaking than were contemplated at setting out. These chiefly arose from having to walk round numerous lakes, which, in the eastern division of the island, are generally surrounded with wood; and from the ground being covered with snow, to a considerable depth, after the 15th of October.

My courses were determined merely by a pocket compass; from which circumstance, and from being the first traveller over this country, I only had it in my power to ascertain its general nature and outline (Plate VI.); and consequently, it is not to be understood that the lakes, rivers, and mountains, are so accurately laid down as they might have been in more favourable circumstances.

There is much more of the interior under water than appears to be from the sketch; it may be said, within bounds, at least one-third of the whole of it.

The first rocks we met with were granite and porphyry. These were succeeded by alternations of granite and mica-slate, which, in their turn, were replaced by granite. Granite, sienite, porphyry, mica-slate, clay-slate, and quartz-rock, occur in the district occupied by Melville Lake. In the same district there are several kinds of secondary sandstone, belonging, probably, to the coal and red sandstone formations. The primitive rocks extend onwards to Gower's Lake. The shores of this lake bear a strong resemblance to the shores of Fresh-water Bay near St John's. This lake has also a dry stony bar, or bank, about its middle, running nearly across from its north-west side; the other has a bar extending across, and separating the fresh water from the salt.

From Gower's Lake, by Jenette's Lake, Emma's Lake, Christian's Lake, Stewart's Lake, Richardson's Lake, the country is almost entirely of old rocks, apparently of the primitive class; the only indications of secondary rocks being the agates near Gower's Lake, the basalt at Emma's Lake and Jenette's Lake, and the indication of coal and iron near Stewart's Lake. The serpentine deposite is succeeded by a great tract of granite, gneiss, and quartz, which extends from Jameson's Lake, by Bathurst's Lake, Wallace's Lake, Wilson's Lake, King George

the Fourth's Lake, to St George's Harbour, in the Bay of St George, on the west coast of the island *.

About the centre of the island are several ridges of serpentine. Here this rock is seen in all its beautiful and numerous varieties; and this occurs particularly on the shores of Serpentine Lake. The Serpentine Mountain and Jameson's Mountain also abound in this interesting mineral.

The west coast is by far the richest in minerals. There is coal of a good quality in St George's Bay, about eight miles from the sea-coast, up the South Barrasway River. There are several salt springs: one about two miles from the sea-coast, up another Barrasway River, some miles north of that where the coal is found; another, a few miles still farther north, up what is called Rattling Brook; and a third at Port-a-Port. There is a strong sulphurous spring, close to the sea-shore, about a mile north of the Barrasway River, where the salt-spring first mentioned is found, (apparently what is called the Second River by the chart). Gypsum and red ochre abound between these rivers and Flat Bay, at the sea-shore; and the former is also found some miles within the country. There is a dark grey coloured marble found at Bay of Islands; but, from report, in no great quantity near the coast. The soil of St George's Bay is good, and not so rocky as in most parts of the island.

There does not appear to be any good soil in the interior. It is almost invariable peat marsh, more or less wet, according to situation, the more elevated parts being rocky. The stunted woods almost invariably indicate its poverty. The short summer does not allow the sun sufficient time to draw out, even from the more elevated *sloping* districts *in their natural state*, the wet of the preceding winter. The best soil in the island is near the sea coasts, particularly the banks next to the mouths of some of the large rivers.

The eastern half of the interior is a low picturesque woody country, traversed northerly and southerly by successive ridges of low hills. The western half is mountainous, often rugged,

* I have used the customary privilege of giving names to the lakes and mountains I met with in this hitherto unexplored route, and these are in compliment to distinguished individuals and private friends. The rocks I collected were examined by Professor Jameson.

barren and nearly destitute of wood; but the mountains here do not lie in ridges, nor in any particular direction, and the lakes and rivers are much larger than to the eastward.

The most extensive lake in Newfoundland is called the Bay of Islands Lake, said by the Indians to be 60 miles long. The second is called the Lake of the Red Indians.

The largest river is Exploit River. The river of East Bay, in the Bay of Despair, admits of the Micmac Indians taking up their birch-bark canoes from the sea coast to Serpentine Lake. After that, they go on their hunting excursions, from lake to lake, in skin canoes, by means of the rivers, and, occasionally, by portages. From St George's Bay there is a portage of upwards of twenty miles to George the Fourth's Lake, before the Indians enter upon the great lakes of the interior.

Roads, or rather paths, which would admit of horses and cattle passing in summer, could be made across any part of the interior. The chief labour and expence attending their formation, would consist, in surveying the routes, to avoid lakes, and, in general, woods; the latter frequently covering very rocky districts. With proper and seasonable care, considerable quantities of wild hay could be procured from the marshes. Were Government to countenance the facilitating a communication overland, between St John's and the neighbouring bays, the intercourse would become more frequent and less dangerous than it has been, particularly in winter.

In a botanical point of view, the interior does not appear to be particularly interesting, after having examined the country near the sea coast. The Island altogether, however, affords a wide field for research to the botanist, particularly as to shrubs. The naked parts of the country, in general, including the marshes, exhibit appearances of having been once wooded. Roots and trunks of trees are generally found under the surface. Many are of larger dimensions than any now growing in their vicinity. They have evidently been destroyed by fire; and from the poor soil in this cold region several centuries seem necessary to produce a forest of any magnitude. A thin wiry grass, with lichens and mosses, cover the marshes; and these, with whortleberry bushes, and several diminutive shrubs, predominate on the higher unwooded districts. Spruces, Larch, and Birches,

compose the woods. The pine is seldom seen, and is commonly so stunted or shrubby, as to be of little value for timber. The mountain-ash is sometimes met with. The only good timber in Newfoundland grows near the sea coasts, and particularly, on the banks of the large rivers, where the best soil is found.

The western division being nearly destitute of wood, affords pasture to numerous herds of deer (the *Carribou*). Of these animals there are here many thousands; indeed, the country seems covered with them. They migrate eastward to the woody districts in winter, and return westward very early in spring. Their flesh forms almost the sole subsistence of the Indians.

Beavers have, in former times, abounded in all the woody districts, and in some places considerable numbers of them are still found, particularly north of the Bay of Despair and Fortune Bay, and in the vicinity of White Bay.

The other wild animals of the country are not numerous, except foxes, near the sea-coast.

Geese, ducks, and gulls, with some other aquatic birds of passage, breed in considerable numbers in the interior. They collect in flocks, and leave it for the coast, as soon as the ponds are frozen over.

The Micmac Indians visit the interior chiefly in pursuit of beavers. They generally allow the different districts where these animals are found, a periodical respite of three years, visiting them alternately in the autumn, in small hunting parties. On these occasions the Indians generally take their families with them. The canoes used on the lakes are partly from necessity, and partly for the sake of convenience, made of basket-work, covered over outside with deer-skins; the latter requiring to be renewed commonly once in six weeks. In construction these canoes resemble those of the ancient Britons.

The whole number of this tribe in Newfoundland does not, in as far as I could learn, much exceed 100. They are generally divided into three bands; one at Flat Bay in St George's Bay; one at Great Cod Bay river, and one at Bay of Despair, near Weasel Island. Part of them occasionally resort to two or three favourite places on the coast.

The attention of Government has several times been turned towards endeavouring to open an intercourse with the Red In-

dians. All attempts hitherto to accomplish this object have been unsuccessful. The failure may, on very good grounds, be attributed to the interference of the Micmacs. The latter are jealous lest, if any intercourse were established with the English, the others should share in the fur trade. To prevent this, they take most effectual methods of impressing these timid creatures with a dread of their fire-arms, and of leading them to entertain the same fears from the fire-arms of the English.

The value of this piece of policy appears to be well understood by the Micmacs, and has been pursued unknown to the English. By a judicious management, however, the Micmacs might be made instrumental in bringing about the intercourse so much desired. As a first step towards it, it might not be improper for our Colonial Government to threaten in a manner suited to the occasion, such of the Micmacs as injure any of the other tribe, with severe punishment, and offer rewards to such of them as will interfere and bring about a friendly intercourse between the Red Indians and the English.

The Red Indians are not numerous. Judging from the extent of country which they inhabit, their number cannot exceed a few hundreds. They do not appear to go now farther south into the interior, than the vicinity of the Great Lake, the shores of which they inhabit, and which bears their name. They communicate with the sea from this lake by Exploit River.

It is a common report that the Micmacs plunder this tribe of their furs. There is no doubt that they frequent the Red Indian territory, and studiously conceal from the English the nature and object of such visits.

The Micmacs say, among other things, of the Red Indians, that they catch deer in the *pound*, and kill them with spears, and that they dry great quantities of their flesh in autumn, as provision for winter. They also complain, that when they are encamped in the country of the Red Indians, the latter, during the night, steal their axes. And they even affirm that this tribe are in the habit of devouring each other.

I discovered no traces of them, although I was, by the account of some Micmacs whom I met with hunting in the interior, at one time within twenty-five miles of their country.

I regretted very much that the smallness of my party, and more particularly the late season of the year, rendered it imprudent to go far enough north, to have an opportunity of seeing them.

To the Right Honourable Earl Bathurst,
Secretary of State for the Colonies, &c. &c. &c.

W. E. CORMACK.

ART. XXVI.—*Remarks on the Vegetation of the Danish Provinces.* By Professor HORNEMAN *.

OF the Danish Provinces, Zealand is the richest in plants, and contains 56 species, which have not been discovered in the other parts of Denmark. This, however, is certainly owing to its having been more thoroughly investigated than any of the others.

A sensible difference may be observed between the Floras of the NE. and SW. parts of this island: the division may be well shewn, by drawing a line from Copenhagen to Nyekiöbing. Several plants occur in the SW. parts which are not found in the NE., though none have been remarked in the latter, which have not also been found in the other parts.

Jutland comes next, having 35 plants peculiar to itself. Were this promontory as well examined as the other provinces, the result would undoubtedly be to its advantage, as the influence of the Continent is very evident in it. Not one of the Danish provinces, in so short a space, shews such a difference in the natural productions as the east and west coasts of Jutland: the former possesses a fertile soil and a flourishing vegetation, while the latter consists of an almost entirely barren and constantly moving sand. Between the two extends that remarkable heath, which stretches from the point of Skagen far into Germany.

In that part of Jutland north of Randersfiord, we find marks of a more northern vegetation. In Vensyssel *Cornus suecica* is abundant, in other parts of Denmark it is rare.

The following plants appear to have attained their most northern limits in Jutland: *Veronica longifolia*, *Sesleria (Aira)*

* Extracted and translated from Professor Horneman's paper in the Transactions of the Danish Philosophical Society, 1821.

glauca and *cristata*, *Festuca bromoides*, *Exacum filiforme*, *Eryngium campestre*, *Leucojum æstivum*, *Colchicum autumnale*, *Asarum europæum*, *Chelidonium glaucium*, *Digitalis purpurea*, *Lunaria rediviva*, &c.

The plants which have been cultivated for arresting the progress of the sand-flood in North Jutland are *Elymus arenarius*, *Arundo arenaria*, and *Carex arenaria*. *Arundo baltica* (Flor. Dan. t. 1634), which has been used with success in Meklenborg, is also recommended for the purpose.

"From the year 1539, there have been several royal ordonnances against the destruction of plants growing on the sand-hills; but it was not till 1779 that any attempt, worthy of notice, was made to arrest the progress of the sand-flood, when an ordonnance was issued for the district of Thisted, which, in 1792, was extended to the rest of the country; and a commission was appointed to superintend the operations carried on to stop the sand-flood, and to reclaim the land which had been covered by it. At that time the sand covered 112,159½ tons of land, at 14000 [ ] ells each, of which, at the end of the year 1816, 74,658 tons had been recovered."—*Esmarck's Account of the Sand-flood in North Jutland.*

Funen has, with a few exceptions, the same Flora as Zealand. The plants peculiar to it amount to 12.

Laaland and Falster are of a low and clayey nature; and consequently produce several plants, which are more rare on the other islands, where the soil is more sandy, and not so moist. Laaland had long an article of trade in the manna-groats (the seed of the *Poa fluitans*, which is used for food in the North of Europe); it is, however, now destroyed, by the draining of the mosses, &c.

The plants peculiar to these islands amount to 10.

Althæa officinalis and *Asparagus officinalis* are here certainly near their most northern limit, and *Ligusticum scoticum* near its most southern.

Moen, though the smallest of these provinces, has long been known for its rich Flora, which it owes partly to its more southern situation, and partly to the variety of its soils, and particularly its chalk-hills, on which occur an abundance of the Orchideous plants, which are either not found at all, or but very

rarely in the other parts of Denmark.—The number of plants peculiar to it are about the same as in Laaland.

Bornholm contains several subalpine plants, which it has in common with the southern and lower parts of Sweden and Norway. *Carex extensa*, *Ulex europæus* and *Melilotus ornithopodioides*, appear to have reached their most eastern and northern limits on Bornholm. Most of the subalpine plants grow on the primitive rocks; the top of Bytterkneg'en, which is in this district, is the highest point of Denmark; and according to Oersted and Esmarck, it is not more than 500 feet above the level of the sea.

In this island, which has as yet been but slightly examined, we find about as many plants as in Laaland, which are not in the other islands.

Sleswick only possesses 5 species, which are not found in the Danish provinces, or in Holstein, and 12 which are not found in Denmark, but which it has in common with Holstein and Lauenborg.

In Holstein are 77 species, which do not occur in the Danish provinces, 35 of which are not in the other duchies.

Menyanthes nymphoides has its northern limit in the marshes of Holstein, and *Chondrilla juncea*, near Oldenborg, where *Isoetes lacustris* is abundant. *Poa sylvatica* is first met with about Flensborg. In the neighbourhood of the salt-springs, near Oldesloe, grow a number of plants, whose natural situation is the sea-shore, though here they are several miles from it; as, *Salsola Kali*, *Poa maritima*, *Plantago maritima*, (which also occurs in the interior of Jutland,) *Atriplex littoralis*, and several others: In this neighbourhood *Polygonum bistorta* first appears.

The reason why Holstein is so much richer than Sleswick, may be partly from its freer communication with the Continent, by the help of the Elbe, and partly from its more southern situation; for as to soil, &c. they are much alike.

Lauenborg is situated near Mecklenborg, a land which shews an extraordinary anomaly in possessing plants belonging to a much more northern vegetation, as *Ledum palustre*, *Linnæa borealis*, *Pedicularis sceptrum*, *Cinclidium stygium*, &c. It possesses 104 species which are not found in the Danish provinces, 66 of which do not occur in the other duchies

The Danish provinces (exclusive of Iceland, Faroe, and Greenland) contain, as far as is known, 1197 species of *Monocotyledonous* and *Dicotyledonous*, or perfect plants.

Of these, 322 belong to the *Monocotyledonous*, a few more than $\frac{1}{4}$th.

Consequently the *Dicotyledonous* are 875, or $\frac{3}{4}$ths of the whole number; the same proportion that Humboldt gives (in *Prolegomena* to *nova gen. et species)* for the Temperate Zone.

Of the *Glumaceæ*, amongst which are reckoned also the *Cyperoideæ*, *Junceæ* and *Typhaceæ*, there are found 216 species. The proportion these bear to all the *Monocotyledones* is as 2 to 3, or with regard to the whole number of phænerogamous plants nearly as 1 to 6; so that this answers very well to Humboldt's proposition, according to which Germany has a proportion of these families to the other perfect plants as 1 to 7; Lapland as 1 to 5. It shews also that the established principle, that the number of the *Grasses* in proportion to the other *Monocotyledonous* and *Dicotyledonous* plants increases towards the Poles, is right.

Of the family of the *Orchideæ* are found 26, about $\frac{1}{46}$. This does not quite agree with Humboldt's representation, supposing that this family diminishes towards the Poles, as the proportion in Germany is $\frac{1}{13}$; in Lapland $\frac{1}{17}$.

The decrease of the family of the *Labiatæ* from the temperate zone towards the Poles is very remarkable. The proportion it bears to the other is, in France as 1 to 24; in Germany as 1 to 26, and, in Finmark, as 1 to 71; so that we might expect that the proportion in Denmark would be about 1 to 30; but this is not the case, for that country possesses 48 species of this family, which is little less than $\frac{1}{24}$th of the whole number; so that the proportion is greater for Denmark than for Germany.

Of the *Compositæ*, Denmark possesses 112 species, about $\frac{1}{11}$th of all its perfect vegetables. This agrees very well with Humboldt's calculations, in as far as this family decreases in number from the warmer zone to the Pole, as the proportion in Germany is as 1 to 8, and in Lapland as 1 to 13, though according to *Wahlenberg's* Flora, the proportion is as 1 to 14.

Of the family of the *Umbelliferæ*, which diminishes both towards the Equator and towards the Poles, there are in Denmark 52 species, $\frac{1}{23}$d of the whole.

As the proportion in Germany is as 1 to 22, and in Lapland as 1 to 55; so the proportion given for Denmark agrees very well with the progression, according to which these plants spread from the Pole to the temperate climate.

The *Cruciferæ* attain their maximum in the temperate zone, but do not decrease in the same degree towards the Poles as towards the Equator, where they almost entirely disappear.

Of these, 53 species are found in the Danish provinces. The proportion is therefore nearly as 1 to 22, which is considerably less than in Germany, where it is as 1 to 18, and a little larger than in Lapland, where it is as 1 to 24.

The family of the *Malvaceæ*, which has its maximum between the Tropics, entirely disappears at the Pole; so that we may expect that the number of them should not be great in this country; which is the case, as there are only 6 species. The proportion here is as 1 to 199.

An anomaly here appears, which is, that although there are two species less of this family than in Germany, where there are found eight, the proportion is greater than in that country, where it is as 1 to 235. This anomaly, however, almost disappears, if we omit *Malva moschata* of the *Danish* Flora, to which it hardly belongs, as it has probably escaped from gardens.

The family of the *Caryophyllaceæ*, with regard to the smaller plants reckoned in it, as the genera *Stellaria*, *Arenaria*, *Spergula*, &c. has its maximum towards the Poles; these small plants are either annual, or so small that they are easily covered and sheltered by the snow. The number of this family in Denmark amounts to 54; so that the proportion is as 1 to 21; in Lapland it is as 1 to 17, and in Germany as 1 to 21; so that the given progression towards the Poles is confirmed by this.

In Denmark are 59 species of *Leguminosæ*, about $\frac{1}{20}$th of the whole sums. In Germany, the proportion is as 1 to 18; in Lapland as 1 to 35.

The *Amentaceæ* amount to 33, nearly $\frac{1}{35}$th of the *Phænerogamous* plants. In Germany, their proportion is as 1 to 39; and in Lapland as in 1 to 17.

ART. XXVII.—*Celestial Phenomena, from January 1. to April 1. 1824, calculated for the Meridian of Edinburgh, Mean Time.* By Mr GEORGE INNES, Aberdeen.

The times are inserted, according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension*.

JANUARY.

D	H	′	″	
1.	7	57	42	● New Moon.
	11	16	0	☌ ☽ ♅
2.	9	54	0	☌ ☽ ☿
3.	0	48	0	☌ ☉ ♅
5.	2	32	58	Em. I. sat. ♃
	15	56	18	☌ ☽ ϑ ♒
6.	21	1	35	Em. I. sat. ♃
7.	1	59	16	Em. II. sat. ♃
9.	12	30	5	☽ First Quarter.
11.	16	50	0	☌ ☽ ♄
12.	4	27	25	Em. II. sat. ♃
	17	6	7	Im. III. sat. ♃
	20	12	51	Em. III. sat. ♃
13.	22	56	4	Em. I. sat. ♃
14.	4	36	41	Em. II. sat. ♃
	22	44	0	☌ ☽ ♃
15.	7	24	42	Em. I. sat. ♃
	18	11	31	☌ ☽ δ ♊
16.	1	42	6	Im. IV. sat. ♃
	3	31	3	Em. IV. sat. ♃
	8	46	56	○ Full Moon.
17.	17	55	48	Em. II. sat. ♃
	22	14	19	☌ ☽ ξ ♌
18.	2	11	44	☌ ☽ ο ♌
19.	21	5	46	Im. III. sat. ♃
20.	0	13	16	Em. III. sat. ♃
				☿ greatest elong.
21.	0	37	24	☉ enters ♒
	0	50	42	Em. I. sat. ♃
	2	0	0	☌ ☽ ♂
22.	19	19	21	Em. I. sat. ♃
23.	1	45	21	☾ Last Quarter.
24.	20	33	10	Em. II. sat. ♃
25.	16	45	37	☌ ☽ σ ♏
	20	23	43	☌ ☽ α ♏
26.	16	56	24	☌ ☽ A Oph.
27.	1	5	54	Im. III. sat. ♃
	1	22	0	☌ ☽ ☿
	4	14	16	Em. III. sat. ♃
28.	1	50	13	☌ ☽ λ ♐
	2	45	28	Em. I. sat. ♃
	20	37	0	☌ ☽ ♅
29.	21	14	9	Em. I. sat. ♃
31.	3	49	3	● New Moon.
	15	1	0	☌ ☽ ♀
	23	10	33	Em. II. sat. ♃

Moon Eclipsed January 16. 1824, *partly visible.*

	D	H	′	″
Begins, Jan.	16.	7	14	42
☽ sets eclipsed,		8	5	0
Middle,		8	40	50
Ecliptic ☊,		8	46	56
End,		10	6	59

Digits eclipsed, 9° 18′ 37″, by the south side of the Earth's shadow, or on the north part of the Moon's disk.

February.

D	H	′	″	
1.	19	41	56	Im. IV. sat. ♃
	21	47	2	Em. IV. sat. ♃
	21	59	22	☌ ☽ ϑ ♒
5.	23	9	5	Em. I. sat. ♃
7.	17	37	51	Em. I. sat. ♃
8.	1	15	0	☌ ☽ ♄
	1	47	52	Em. II. sat. ♃
	3	4	26	☽ First Quarter.
10.	18	56	46	☌ ☽ 132 ♉
11.	5	28	0	☌ ☽ ♃
12.	5	19	50	☌ ☽ δ ♊
13.	1	4	7	Em. I. sat. ♃
14.	19	25	22	○ Full Moon.
	19	32	56	Em. I. sat. ♃
	21	48	11	☌ ☽ π ♌
18.	1	22	0	☌ ☽ ♂
	17	43	21	Em. II. sat. ♃
19.	15	21	2	☉ enters ♓
20.	2	59	16	Em. I. sat. ♃
21.	17	16	45	☾ Last Quarter.
	21	28	5	Em. I. sat. ♃
22.	23	15	30	☌ ☽ A Oph.
24.	8	1	9	☌ ☽ λ ♐
	20	16	7	Em. III. sat. ♃
25.	5	36	0	☌ ☽ ♅
	20	20	30	Em. II. sat. ♃
26.	9	44	0	☌ ☽ ☿
27.	11	17	0	☌ ☽ ☿
28.	23	23	20	Em. I. sat. ♃
29.	22	38	41	● New Moon.
				☿ greatest elong.

March.

D	H	′	″	
2.	21	5	[illegible]	Im. III. sat. ♃
3.	0	17	19	Em. III. sat. ♃
	22	57	28	Em. II. sat. ♃
6.	8	16	0	☌ ☽ ♄
7.	1	18	39	Em. I. sat. ♃
8.	14	7	43	☽ First Quarter.
	19	47	27	Em. I. sat. ♃
9.	2	27	38	☌ ☽ 132 ♉
	13	12	0	☌ ☽ ♃
10.	1	5	21	Im. III. sat. ♃
	14	10	4	☌ ☽ δ ♊
11.	1	34	1	Em. II. sat. ♃
12.	20	21	10	☌ ☽ ξ ♌
13.	0	18	53	☌ ☽ ο ♌
15.	5	53	11	○ Full Moon.
	21	42	51	Em. I. sat. ♃
16.	3	1	0	☌ ☽ ♂
20.	7	34	27	☌ ☽ σ ♏
	15	26	46	☉ enters ♈
21.	6	58	18	☌ ☽ A Oph.
22.	11	5	0	☾ Last Quarter.
	23	38	17	Em. I. sat. ♃
23.	14	25	0	☌ ☽ ♅
27.	16	54	0	☌ ☽ ♀
28.	20	5	59	Em. II. sat. ♃
29.	12	22	0	☌ ☽ ♉
30.	14	53	50	● New Moon.
31.	20	2	38	Em. I. sat. ♃

Art. XXVIII.—*Proceedings of the Royal Society of Edinburgh.* (Continued from Vol. IX. p. 192.)

Nov. 3. 1823.—The Royal Society resumed its sittings for the ensuing session.

A paper, containing astronomical observations made at Paramatta and Sydney by his Excellency Sir Thomas Brisbane, Bart. K. C. B. and Mr Rumker, was read. This paper contained, 1. A series of observations on the comet of September 1822, and also their comparisons with the result of its elliptic

elements. 2. Observations on the Transit of Mercury on the 3d November 1822, Sir Thomas Brisbane having proceeded to Sidney, at the distance of fifteen miles, for the purpose of observing it, while Mr Rumker observed it at Paramatta. 3. Observations on the Winter Solstice of 1822; and, 4. Observations of the Comet of Encke during the month of June 1822.

On the same evening, there was read *Remarks on the Natural-Historical Determination of Diallage*, by W. Haidinger, Esq.

Professor Wallace read a paper, entitled, *Investigation of Formulæ for finding the Logarithms of Trigonometrical Quantities from one another*; and also a paper entitled, *A proposed Improvement in the Resolution of a Case in Plane Trigonometry.*

Nov. 17. Dr Knox read a paper *On the Limits of the Retina in the Eye of the Sæpia loligo.*

Nov. 24. At a General Meeting of the Society, the following gentlemen were elected Office-bearers and Counsellors for the ensuing year:

Sir WALTER SCOTT, Bart. President.

Vice-Presidents.

Right Hon. Lord Chief-Baron,	Lord Glenlee,
Dr T. C. Hope,	Professor Russell.

Dr Brewster, General Secretary.

Thomas Allan, Esq. Treasurer.

James Skene, Esq. Curator of the Museum.

PHYSICAL CLASS.

Alexander Irving, Esq. President.	John Robison, Esq. Secretary.

Counsellors from the Physical Class.

Sir James Hall, Bart.	Robert Stevenson, Esq.
Dr Kennedy.	Sir William Arbuthnot, Bart.
Rev. Dr Macknight.	James Jardine, Esq.

LITERARY CLASS.

Henry Mackenzie, Esq. President.	P. Tytler, Esq. Secretary.

Counsellors from the Literary Class.

Thomas Thomson, Esq.	Professor Wilson.
George Forbes, Esq.	Sir William Hamilton, Bart
Lord Meadowbank.	Rev. Dr Lee.

Dec. 1. There was read a paper *On a Remarkable case of Magnetic Intensity of a Chronometer*, by George Harvey, Esq. M. G. S.; M. A. S.

There was likewise read a paper, *On the Enlargement of the Mamillæ of Males at the age of Puberty*, by John Bremner, Esq. Member of the Royal College of Surgeons, London.

Professor Russell read an account of a Parhelion observed at Darlington, by Mr Cumming.

At this meeting the following gentlemen were elected members:

FOREIGN.

M. Thenard, Professor of Chemistry in the College of France.

ORDINARY.

Robert Knox, M. D.
Robert Christison, M. D. Professor of Medical Jurisprudence.
John Gordon, Esq. of Cairnbulgh.
George Bellie, M. D. Leith.

Dec. 15. A paper by Dr Brewster was read, *On the Accommodation of the Eye to different Distances.*

Dr Knox read a paper *On the Comparative Anatomy of the Base of the Iris, and of its mode of Union with the Cornea, and the Annulus albus.*

At this meeting, Mr Adie exhibited to the Society the experiment of Professor Dobereiner on the action of platina on hydrogen gas, already fully explained in this Number, p. 173.

Professor Wallace exhibited to the Society one of his improved Eidographs, for copying and reducing plans and drawings.

ART. XXIX.—*Proceedings of the Wernerian Natural History Society.* (Continued from Vol. IX. p. 390.)

Nov. 15. 1823.—THE Secretary read a communication from the Rev. Mr Dunbar of Applegarth, confirming Shirach and Huber's doctrine of the occasional conversion of the larvæ of working bees into queen-bees. (This paper is printed in the present Number of our Journal, p. 22.)—He likewise read a notice from Dr Cumine of Glasgow, regarding the formation of young tubers, within the substance of a large potato, the original specimen being at the same time exhibited. And also a paper "*On the natural and economical history of the Cocoa-nut tree,*" by Mr Marshall, staff-surgeon.

At the same meeting, Dr Knox gave an account of the *Fora-*

men centrale of Sömmering, as discovered by him in the eyes of certain reptiles, illustrating his communication by beautiful anatomical preparations.

Mr Parry exhibited Colonel Miller's newly invented percussion shell, and gave an account of some very successful experiments made with it near Leith Fort.—And Mr Nicol repeated, in presence of the meeting, Professor Doberciner's remarkable experiment, shewing the ignition of the fine powder of platina, when exposed to a stream of hydrogen gas in atmospheric air.

Nov. 29.—Dr Knox read a paper on the organs of digestion, respiration and circulation of the Ornithorynchus paradoxus, illustrating his description by specimens and drawings.

The Secretary read the concluding part of Dr Fleming's gleanings of Natural History, during a voyage along the coasts of Scotland in 1821. Likewise, a notice, by Mr R. Lindsay of Aberdeen, of a shower of remarkable pyramidal hailstones, which fell at Aberdeen in June last.

Mr Parry exhibited some drawings made from carvings in oak, executed previous to the time of Henry VIII. And Professor Jameson laid before the meeting a chart, shewing the route pursued by Captain Parry through various parts of Baffin's Bay, during the three preceding summers.

At this meeting the following gentlemen were elected office-bearers of the Society for the ensuing year:

Robert Jameson, Esq. President.

Vice-Presidents.

Dr David Ritchie.	R. K. Grèville, Esq.
The very Rev. Principal Baird.	Rev. James Grierson, M. D.
Pat. Neill, Esq. Secretary.	James Wilson, Esq. Librarian.
A. G. Ellis, Esq. Treasurer.	P. Syme, Esq. Painter.

Council.

Robert Bald, Esq.	Alexander Adie, Esq.
Professor Dunbar.	William Drysdale, Esq.
Sir William Jardine, Bart.	Gilbert Innes, Esq.
Professor Graham.	Dr Robert Knox.

The following new members were also admitted:

Resident.

Henry Witham, Esq. of Lackington.
Edward William Auriol Hay, Esq. A. B. Oxon.
The Rev. Dr Alex. Brunton, Edinburgh.

FOREIGN.

The Rev. Thomas Macculloch of Pictou.

CORRESPONDING.

Mr William Macgillivray.

Dec. 13. Dr Knox read a paper on the kidneys, urinary bladder, and organs of generation in the male of the Ornithorynchus paradoxus, illustrating his description by sketches. Dr Yule gave an account of the changes produced on some tallow-candles, accidentally preserved in a dry state for nearly a century, and exhibited specimens. Mr Greville read an account of Mr Cormack's Journey across Newfoundland, in the autumn of 1822. (This interesting communication is printed in the present number of this Journal p. 156., and illustrated by a map, constructed by Mr Cormack.)

At the same meeting, Professor Jameson gave an account of thermometric and hygrometric observations made at Port Callao in South America, by Mr William Jameson, surgeon; and read extracts of a letter, written from Funchal, by Mr Bowdich, the African traveller.

ART. XXX.—*Proceedings of the Cambridge Philosophical Society, for* 1823. (Continued from Vol. VIII. p. 388.)

Feb. 17.—A communication was read from J. Hogg, B. A., F. L. S., and Fellow of the Cambridge Philosophical Society; giving the description of an Oolitic Bed in the Magnesian limestone formation, at Hartlepool in the county of Durham.

A letter was read from W. J. Banks, M. A., Fellow of the Cambridge Philosophical Society, M. P. for the University, accompanying a description of the late earthquake at Aleppo, transmitted to Mr Banks, by Mr Salt from Alexandria.

A paper was read from B. Bevan, Esq., containing an account of some experiments on the vibrations of strings, by which it appears that the times of their vibrations agree with those deduced from theory, by Dr Smith and others.

March 3.—W. Whewell, M. A., Fellow of Trinity College, read a notice of some mathematical calculations, proceeding on Mr Ampere's theory of Electro-Magnetism, or, as the author

proposes calling it, Electro-Dynamics. The object of these investigations was to compare the results of this theory with that of Mr Barlow, and with experiment; but they will require further development, before they can be considered as sufficiently complete.

A paper was read by Professor Sedgwick, M. A., F. R. S., Fellow of Trinity College, "*On the Association of Trap-Rock, with the Mountain Limestone Formation in High Teesdale,*" &c.—The author commences with some general remarks on the structure of the great calcareous chain in the north of England. He then shews the great importance of the transverse valleys; the upper and lower portions of which often exhibit a double system of sections, by which the relation of the formations are completely ascertained. He afterwards proceeds to examine the structure of the Higher Teesdale, and explains at considerable length the modifications which have arisen from the existence of many *faults* of extraordinary length and magnitude. In this part of the paper, he *first* shews the want of correspondence in the strata on the two sides of the valley, which extends 5 or 6 miles above Egglestone; more especially the appearance of a great bed of trap on the south-west side, to which no bed corresponds on the north-east side.

2. He describes the phenomena exhibited by the trap after its first appearance in the bed of the river, till it crosses in the form of a great dam at the High Force.

3. He describes the appearance of a great fault, which intersects the whole valley about a mile above the High Forse, and throws the whole system of strata, on the north-west side of its range, more than 20 fathoms above their previous level. In the latter part of the paper, the author proceeds to examine the phenomena presented at the junction of the trap with the other strata, and he arrives at the following conclusions.

(1.) That the great mass of trap (the *whin-sill*), may be traced to a point within a few hundred feet of the mass of trap, which is prolonged into the coal measures in the form of a dike.

(2,) That the *whin-sill* is not a regular bed, but a great wedge-shaped mass, which becomes thickest in the upper part of the valley.

(3.) That it is interlaced with the other strata, in such a way as cannot be accounted for by any hypothesis of tranquil deposi tion, and subsequent dislocation.

(4.) That the strata in contact with the trap are always changed. The limestone, under such circumstances, is partially converted into a mass as white as statuary marble, in which the impressions of shells are entirely effaced. At greater distances from the trap the change is partial. The shale, under like circumstances, undergoes many remarkable changes. In some places it is constructed into a hard porcelanous mass. In others it puts on a slaggy cellular appearance, and the cavities are often studded with minute garnets, &c. &c.

From all these facts, the author concludes,

1*st*, That the great faults in Teesdale have originated in the operation of causes, similar to those which have produced those dislocations in the coal measures which are described in a previous paper.

2*d*, That the whin of Teesdale originated in the same system of causes which produced (though perhaps not contemporaneously), the great whin-dikes in the coal measures of the same district.

March 17.—Professor Sedgwick concluded the reading of his paper.

T. E. Bowdich, Esq. forwarded to the Society a Botanical description of Madeira. In this communication, Mr Bowdich has given a list (including 277 genera), containing the indigenous, naturalized, and cultivated plants, found in Madeira. Of the indigenous plants, he has detected 149 genera. He describes their geographic distribution, and concludes his paper with an enumeration of 17 new genera, 10 of which are among the Cryptogamous, and 7 among the Phænerogamous plants of the island.

April 14.—W. Whewell, M. A., Fellow of Trinity College, read a historical notice on the attempts which have been made to grind optical glasses and mirrors by machinery, and to give a parabolic form to them.

Rev. G. Peacock, M. A., F. R. S., Tutor of Trinity, commenced a paper upon some points of mathematics connected with the Newtonian discoveries.

A new proof of the propositions respecting the composition of forces, by J. King, M. A., Tutor of Queen's College was read.

April 28.—A paper was read by Professor Cumming, *On the Relative Polarities of the Metals as developed by Heat.* After noticing the apparent similarity between the well known experiment of exciting by heat the opposite states of electricity in the tourmaline, and the experiments of Dr Seebeck, on a bar of antimony, related in the last Number of this Journal, the magnetic effects of heat on other simple metals and alloys is examined. All the metals were found to exhibit these effects, provided the extremities of the metallic bars were at different temperatures; whether this difference were produced by heating one extremity, or by cooling the other.

Antimony and bismuth were most remarkable as producing greater deviations than any other metals; and, under the same circumstances, the one being positive, the other negative. The electric states of other metals depended on the nature of the connecting wires, and seemed to be modified less by the galvanic relations of the metals, and connecting wires, than by their powers for conducting heat. For instance, the deviations caused by bars of copper, silver, or palladium, were positive or negative, according as the connecting wires were of silver or platina. Deviations were also produced, when the bars and wires were composed of the same metal. The electro-magnetic effects appeared not to depend upon any peculiarity of structure, such as crystallization, for they were not perceptibly altered by the manner of cooling the bars after fusion, and they were exhibited by fluid mercury inclosed in a glass tube. When a bar was broken and connected again by soldering, it acted as two distinct bars. The effects were not materially increased, by increasing the dimensions of the metallic bars, or of the surfaces in contact; but were much augmented by using wires of large diameter, until they reached $\frac{1}{12}$th of an inch, after which there seemed to be no increase of power. When the circuit was increased in geometrical progression, the effects appeared to decrease in arithmetical progression. A bar composed of two rods of antimony and bismuth, heated at both extremities, gave a deviation of 36° to a compass needle $4\frac{1}{2}$ inches long. A battery formed of 8 plates of antimony and bismuth alternately, gave some increase of power,

but by no means in proportion to the number of plates. This battery was incapable of magnetising a needle inclosed in a spiral wire, or of exciting commotions in the limbs of a frog. An alloy of antimony and bismuth gave with a small compass, deviations in the following order: 0, 30° neg.; 0, 30° pos. 0. —the heat being continued until the bar began to melt. When several wires were soldered to a metallic bar in different parts of its length, the intermediate portions being alternately hot and cold, there were as many opposite poles as wires. It was therefore inferred, that if the experiment were possible, there would be found as many poles as the bar contained atoms at different temperatures. The metallic alloys presented nothing remarkable, excepting that the magnetic power of bismuth was readily, but that of antimony was with difficulty counteracted by fusion with other metals. No magnetic effect was produced by heating a tourmaline, with silver wires coiled round its extremities.

The general conclusion of the paper was, that the magnetic relations of the metals as affected by heat, have little or no connection with the galvanic relations, or their affinities for oxygen; but are considerably dependent on the conducting powers of the bars, and the wires connected with them; and that, therefore, any attempt to place them in a series would be incorrect, unless bars and connecting wires of the same metal were employed. It was suggested, that a pyrometer might be constructed on the principle of the magnetic deviations, being employed as measures of temperature.

Tables of the deviations of the different metals and alloys, at different temperatures, and with different connecting wires, were subjoined to the paper.

May 12.—Mr Peacock continued the reading of his paper.

May 13.—Being the anniversary, the Office-bearers and Council were elected for the ensuing year:

President,—John Haviland, M. D. St John's, Regius Professor of Physic.

Vice-Presidents,—
- F. Thackeray, M. D. Emmanuel.
- Rev. W. Farish, B. D. Magdalene, Jacksonian Professor.
- Rev. J. Cumming, M. A., F. R. S., M. G. S., Trinity, Professor of Chemistry.

Treasurer,—Rev. B. Bridge, B. D., F. R. S., Fellow of Peterhouse.

Secretaries, Rev. G. Peacock, M. A., F. R. S., Tutor of Trinity.
T. S. Henslow, M. A., M. G. S., F. L. S., St John's Professor of Mineralogy.

Steward of the Reading Room, W. Whewell, M. A. F. R. S., Fellow of Trinity.

Ordinary Members of the Council,
Rev. T. Chevallier, M. A. Tutor of Catherine Hall.
Rev. A. J. Carrighan, M. A. Fellow of St John's.
Rev. A. Dicken, M. A. Fellow of Peterhouse.
J. King, M. A. Tutor of Queen's.
Rev. A. Sedgwick, M. A., F. R. S., M. G. S., Fellow of Trinity, Woodwardian Professor of Geology.
R. Twopenny, M. A. Fellow of St John's.
M. Ramsay, M. A., F. L. S., Fellow of Jesus.

(To be continued.)

Art. XXXI.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Southern Motion of the Fixed Stars.*—In our last Number, p. 393., we mentioned the *Southern Motion* of the fixed stars, which Mr Pond considers as deducible from his observations; and we stated, at the same time, that this discovery was not confirmed by the observations of the Reverend Dr Brinkley. Mr Pond has published another paper on the subject, in the *Phil. Trans.* for 1823. Part. II. p. 529, in which he draws the same conclusions from the observations made at Greenwich, Armagh, Westbury, and Palermo.

Dr Brinkley, we understand, has transmitted to the Royal Society an elaborate paper on that subject, by which he endeavours to overturn Mr Pond's deductions, from Bradley's observations at Wanstead and Greenwich; Maskelyne's at Scheballien; Piazzi's, at Palermo; Mudge's in England; and Lambton's in Hindostan;—all of which he considers as proving an uniform variation in declination.

Having had an opportunity of seeing Tables illustrative of the subject of the southern motion, and highly interesting in several other points of view, which, we are informed, came from Dr Brinkley, we have obtained permission to publish them.

	TABLE I.			TABLE II.		
	BRADLEY, 1755; PIAZZI, 1800. *Variation in NPD for 10 years at 1818, reduced from variation in 1777.*	PIAZZI, 1800: BRINKLEY, 1823. *Variation in NPD for 10 years at 1818, reduced from variation in 1812.*	BRINKLEY, 1813; BRINKLEY, 1823. *Variation in NPD for 10 years at 1818 difference of Catalogues 1813-1823.*	BRADLEY, 1755; POND, 1800. *Variation in NPD for 10 years at 1818, reduced from variation in 1777.*	POND, 1800: POND, 1823. *Variation in NPD for 10 years at 1818, reduced from variation in 1812.*	POND, 1813; POND, 1823. *Variation in NPD for 10 years at 1818, Difference of Catalogues 1813-1823.*
γ Pegasi,	— 200,5	201,3	200,8	202,0	197,6	198,6
α Cassiopeiæ,	198,3	199,3	198,5			197,0
α Arietis,	173,9	173,7	173,1	172,4	172,3	174,0
α Ceti,	145,3	145,5	145,8	145,8	144,8	144,1
α Persei,	134,4	134,1	135,5			133,4
Aldebaran,	79,3	78,1	78,4	79,9	76,9	77,7
Capella,	44,7	45,8	44,5	45,6	44,1	43,8
Rigel,	47,1	46,9	46,2	47,1	46,9	45,3
β Tauri,	37,3	37,9	37,5	37,5	37,5	37,2
α Orionis,	— 12,9	13,2	11,9	13,7	11,5	11,5
Sirius,	+ 44,3	44,6	44,1	43,3	46,7	47,3
Castor,	71,5	71,5	71,3	71,4	71,8	72,2
Procyon,	86,3	87,8	87,7	86,3	88,0	89,2
Pollux,	80,7	80,3	81,1	88,8	80,1	80,6
α Hydræ,	152,2	152,3	153,2	151,9	153,0	153,2
Regulus,	172,4	173,4	173,6	171,5	174,8	172,8
β Ursæ Maj.	191,1	191,7	191,4			
α	192,9	192,5	193,1			192,2
β Leonis,	200,1	201,1	201,5	199,5	202,5	200,8
γ Ursæ Maj.	200,4	199,2	198,9			199,5
ε	197,6	196,0	196,1			
Spica Virg.	189,7	190,3	190,7	189,4	190,4	189,4
ζ Ursæ Maj.	189,6	189,6	187,7			
η	181,6	182,1	181,5			181,6
Arcturus,	189,6	190,3	190,3	188,6	192,0	190,1
2 α Libræ,	153,1	153,8	155,7			153,2
β Ursæ Min.	148,2	146,6	147,3			146,7
α Cor. bor.	124,2	125,1	124,8	124,3	124,9	125,1
α Serpentis,	117,5	117,3	117,8	116,5	119,2	117,3
Antares,	85,9	85,8	87,3			87,5
α Herculis,	45,2	46,8	45,9			46,4
α Ophiuchi,	30,1	31,8	30,0	29,6	33,1	32,0
γ Draconis,	+ 7,2	6,3	6,6	6,8	7,2	6,9
α Lyræ,	— 30,0	29,9	30,0	30,7	28,3	29,4
γ Aquilæ,	83,3	83,1	83,4			
α	90,8	89,7	90,9	91,6	87,9	89,3
β	85,6	85,4	86,3			
1 α Capricorni,	106,9	105,3	106,4			107,5
2 α Capricorni,	107,1	105,9	105,0	107,6	105,1	107,6
α Cygni,	126,0	125,4	126,3	126,8	123,8	124,7
α Cephei,	149,7	151,5	151,2			149,9
β Cephei,	155,9	157,7	157,0			156,6
α Aquarii,	172,5	172,2	171,4	172,8	174,1	170,0
α Pegasi,	193,3	192,1	191,5	194,4	189,6	190,0
α Andromed.	— 199,2	199,6	198,3	199,5	198,8	197,8

Table I. column 1. is deduced by taking the difference between NPD 1755 * and the NPD 1800 †, and reducing the rate for 10 years, for change of precession, to 1818.

Column 2. in like manner, from Palermo ‡ Cat. 1800, and Dublin Cat. 1823 §.

Mr Pond's observations 1800 were made at Westbury ||.

There are two ways of considering the results in the above Tables.

(1.) Mr Pond deduces, that the variations in NPD are irregular; and he supports his conclusion by the observations from which the numbers in Table 2. are computed. If his observations are exact, this remarkable consequence follows, that the errors of observation at Palermo and Dublin have made the variations in Table 1. appear constant, which are really changeable.

(2.) If we consider Table 1. as supporting an uniform variation in NPD of each star, and there is no greater differences than what might be expected from the unavoidable errors of observations, then it follows, that the Palermo and Dublin observations are more exact than the Westbury and Greenwich observations.

2. *Comet of September* 1822, *observed at Paramatta.*—The following are the elliptic elements of the comet observed at Paramatta by Sir Thomas Brisbane and Mr Rumker, as communicated to the Royal Society of Edinburgh.

Time of passing the perihelion, mean time.	.	Oct. 24,221201
Log. of perihelion on the orbit,	from mean equinox,	271° 36′ 18″.3
Log. of descending node	from mean equinox,	272 42 23
Inclination,	. . . . . .	52 40 41
Logarithm e, ($\phi = 82° 53' 11''$),	. . .	9.9966440
Log. ½ parameter,	. . . . .	0.3585731
Sidereal revolution in days,	. . . .	663554.3

3. *Anomaly in the Figure of the Earth.*—So many ships touch at Madeira, and take a new departure from it, that the longitude of the island is a matter of considerable importance. Dr Tiarks was therefore sent out by the Board of Longitude to

* Bessel, *Astron. Fundament.* † Piazzi, *Great Catalogue of* 1814.
‡ *Journal of Science*, Sept. 1822. § *Phil. Trans.* 1806.
|| For Mr Pond's Observations, see *Phil. Trans.* 1815, and 1823, Part I.

ascertain it, with sixteen watches, in the summer of 1822; and a remarkable circumstance occurred, which was not within the object of his original mission. For, in going from Greenwich to Falmouth, a difference of longitude was found equal to 20′ 11″.49; and, in returning from Falmouth to Greenwich, a difference of 20′ 11″.13. Now, the difference, as determined from the Trigonometrical Survey (given in the third edition of the requisite tables), is only 20′ 6″.9; and this variation made it expedient to engage Dr Tiarks to verify his observations in the Channel. He was furnished with twenty-nine chronometers, and was employed from the latter end of last July till the middle of September in sailing between Dover and Falmouth. His results are as follows:

Longitude of Dover station, . .	0h 5′ 17″.54 E.
Portsmouth Observatory, .	0 4 24 .77 W.
Pendennis Castle, .	0 20 10 .85 W.
Madeira, . . .	1 7 39 .08 W.

From hence it is clear that the figure of the earth must be somewhat different from that assumed for determining the longitudes from the Trigonometrical Survey, and that about 5″ must be added, in the latitude of the Channel, for every 20′ of longitude which is deduced from it.

4. *Reported Inaccuracy of M. Bessel's Catalogue.*—A report relative to an inaccuracy in M. Bessel's Catalogue having not only gone abroad, but having found a place in the *Annals of Philosophy* for November, p. 397, we are happy to have it in our power to contradict this rumour by the following extract of a letter, from M. Bessel, to a gentleman in London: —"With respect to my Catalogue of the declination of the principal stars, I think the information you sent me must be founded on some misunderstanding, as I have not the least suspicion that it is wrong. The effect produced by the bending of the telescope of my circle appears to me to be so well determined, that on this point I can expect no further improvement, without running the risk of greater inaccuracies. In my method both of observation and computation, I have never neglected any thing that could have any influence of consequence. I cannot, therefore, throw any light on what you mention, unless some one would point out inaccuracies at present unperceived by me,

which would produce an alteration. The whole of my proceedings are laid open to every astronomer, in the seventh number of my Observations; and those who devote to them an attentive examination, will nave greater confidence in what I have stated, than by listening to any idle reports."

5. *Anomaly in the Observations at Arbury Hill.*—In levelling from the station of Arbury Hill to the Grand Junction Canal, Mr B. Bevan found that the country to the north of Arbury station fell suddenly about 400 feet, and continued at this depressed state for nine or ten miles. He therefore conceived that this defect of matter to the north of the station was a reason for supposing a deflexion of the plumb line to the southward. In order to ascertain the truth of this supposition, he computed the latitude of Arbury station from that of Blenheim, determined independent of any astronomical observation made at Arbury, and he found it *five seconds* LESS than that shewn by the zenith sector; thus countenancing, in a high degree, the probability of local attraction by the high land to the south of the station. See this Journal, vol. i. p. 200.

The following are the heights of the station which he found by levelling.

	Mr Bevan.	Col. Mudge.	
	Feet.	Feet.	Diff. feet
Wendover station,	861	905	44
Kensworth, .	809½	904	94½
Bowbrickhill, .	571½	683	111½
Arbury Hill, .	740½	804	64½

See *Phil. Trans.* 1823, p. 73—77.

6. *Sir Thomas Brisbane's Experiments on the Pendulum.*—By means of a pendulum belonging to the Board of Longitude, and similar to that used by Captain Kater and Captain Hall, Sir Thomas Brisbane made a series of experiments at Paramatta, in 1822. The pendulum having been swung in London, and observed both by Captain Kater and Sir Thomas Brisbane, it was found that it performed 86090.17 vibrations at London, in Lat. 51° 31′ 8″.4, in a mean solar day, at 60° of Fahrenheit, and in a vacuum. At Paramatta, in E. Long. 151° 0′ 15″, and S. Lat. 33° 48′ 43″, the same pendulum performed 86021.59

vibrations, according to Sir Thomas Brisbane's observations, and 86022.21 according to the observations of Mr Dunlop, his scientific assistant. By comparing Sir Thomas's results with those made in London, Captain Kater has found that 39.07696 inches is the length of the pendulum vibrating seconds at Paramatta; .0052704 the diminution of gravity from the Pole to the Equator, and $\frac{1}{295.84}$ the resulting compression, the seconds-pendulum at London being taken at 39.13929 inches. By comparing the same experiments with those made by Captain Kater, at Unst, in Lat. 60° 45′ 28″ N., the diminution of gravity is .0053605, and $\frac{1}{303.95}$ the resulting compression. By comparing the results of Mr Dunlop's observations with his own in London, Captain Kater finds the length of the seconds-pendulum at Paramatta to be 39.07751, the diminution of gravity .0052238, and the compression $\frac{1}{291.85}$. Comparing these with the Unst observations, the diminution of gravity is .0053292, and the compression $\frac{1}{301.09}$.

ACOUSTICS.

7. *Experiments on the Velocity of Sound.*—A very valuable and elaborate series of experiments on the velocity of sound has been made at Madras, by Mr Goldingham. Various different measures of the velocity of sound had been obtained by different observers, but the discrepancies in their observations were not supposed to arise from the condition of the atmosphere. Mr Goldingham made his experiments with two guns, at the distances of 29,547 feet and 13,932.3 feet. They were 24-pounders charged with 8 pounds of powder, and the experiments were continued during the latter part of 1820, and the whole of 1821. The following table contains the substance of these numerous and well-conducted experiments; and it is curious to remark, how the velocity gradually increases towards the middle of the year, and again gradually diminishes. Mr Goldingham conceives that this regularity would be still greater, with the mean of several years observations

Months.	Barometer in Inches.	Thermometer, Fahr.	Hygrometer, dry.	Velocity of Sound in a Second in Feet.
January,	30.124	79°.05	6°.2	1101
February,	30.126	78 .84	14 .70	1117
March,	30.072	82 .30	15 .22	1139
April,	30.031	85 .79	17 .23	1145
May,	29.892	88 .11	19 .92	1151
June,	29.907	87 .10	24 .77	1157
July,	29.914	86 .65	27 .85	1164
August,	29.931	85 .02	21 .54	1163
September,	29.963	84 .49	18 .97	1152
October,	30.058	84 .33	18 .23	1128
November,	30.125	81 .35	8 .18	1101
December,	30.087	79 .37	1 .43	1099

Mr Goldingham concludes, that for each degree of the thermometer 1.2 feet may be allowed in the velocity of sound for a second; for each degree of the hygrometer 1.4 feet; and for $\frac{1}{10}$th of an inch of the barometer 9.2 feet. He concludes that 10 feet per second is the difference of the velocity of sound between a calm and in a moderate breeze, and $21\frac{1}{4}$ feet in a second, or 1275 in a minute, is the difference, when the wind is in the direction of the motion of sound, or opposed to it.—See *Phil. Trans.* 1823, p. 96–140, and pp. 177, 178. of this Number.

MAGNETISM.

8. *Magnetism of Titanium, Cobalt and Nickel.*—Dr Wollaston having formerly been of opinion, (see this *Journal*, vol. ix. p. 403.), that the entire crystals of Titanium were not attractible by the Magnet when they were freed from adhering particles of iron, had occasion to re-examine them, and found this opinion incorrect. Although the crystals are, in this state, not sufficiently attractible to be wholly supported by the magnet; yet, when a crystal is supported by a fine thread, the force of attraction is sufficient to draw it about 20° from the perpendicular, and, consequently, the force of attraction is equal to about *one-third* the weight of the metal. A cubic piece of soft *iron*, of the same size, and weighing half a grain, had its attractive force to the same magnet such that it was able to lift from 80 to 90 times its weight of a silver chain. *Cobalt* carried from 50 to 60 times its weight; and *Nickel* from 20 to 30 times its own weight. Dr Wollaston considers that the presence of $\frac{1}{230}$th

part of iron, as an alloy, would be sufficient to account for its magnetical qualities. Dr Wollaston has detected, by chemical means, a small quantity of Iron in Titanium, but not enough to account for its apparent magnetism.

9. *Experiments of Mr Barlow and Mr Christie on the Diurnal Variation of the Needle.*—Two very able and elaborate papers on this curious subject, by these two active and acute philosophers, have just appeared in the *Phil. Trans.* for 1823, Part 2d.

From the minuteness of the daily variation, and the extreme difficulty of measuring it excepting with the nicest instruments, its laws, and consequently its cause, are still undiscovered. It occurred to Mr Barlow, that this deviation might be increased, both in the horizontal and in the dipping needle, to between 3 and 4 degrees, by reducing the directive power of the needle, by means of one or two magnets so disposed, as to mask at least, in part, the terrestrial influence. Experiment proved this idea to be correct; and Mr Barlow accordingly instituted a series of experiments. Mr Christie, to whom Mr Barlow communicated his views, also began the inquiry.

Mr Barlow used a delicate and light needle, $8\frac{1}{2}$ inches long; and, by means of two magnets, he kept the needle balanced in different directions of the compass, and in these different directions he observed the daily changes in its position. The following were his results for the *horizontal needle.*

When the N. end of the needle was directed to any point from the S. to NNW., its motion, during the forenoon, is towards the left hand, advancing, therefore, to some point between the NNW. and N. When the N. end is directed towards any point between the N. and SSE., it passes to the right hand, advancing still to some point between the N. and NNW. Hence, there ought to be some direction between these limits, viz. between the N. and NNW., and the S. and SSE., in which the daily motion is zero, or at least a minimum. Mr Barlow likewise concludes, *that the daily change is not produced by a general deflection of the directive power of the earth, but by an increase and decrease of attraction of some point between the N. and NNW., or between the S. and SSE.*

Having reduced the power of a dipping needle nearly 8 times, by two magnets placed in the line of the dip, Mr Barlow observed, that it passed suddenly from one half-quarter degree to another, more or less, so as to give a difference in the dip of $1\frac{1}{2}°$ in one day. It seldom, however, shewed any tendency to return, though, when vibrated at night, it commonly took up its morning position. The same sort of daily motion appeared whether the face of the instrument was to the E., W., N., or S. Mr Barlow is of opinion, that the solar light, and not the solar heat, is the principal operative agent in producing the daily variation.

ELECTRICITY.

10. *Electricity produced by separation of parts.*—In the fine water-proof cloths manufactured by Charles Macintosh, Esq. of Glasgow, where two pieces are cemented together by caoutchouc, dissolved in coal-tar oil, the adhesion is so complete, that when the two are torn from one another in the dark, there is a bright flash of electric light, similar to what is produced by tearing asunder plates of mica, by bursting Prince Rupert's drops, or by breaking barley sugar, or sugar candy. Upon trying this experiment with different substances, we found that flashes of light were distinctly produced, by tearing quickly a piece of cotton cloth.

11. *Prof. Cumming's Table of Thermo-Electrics.*—In the following table of thermo-electrics, by Professor Cumming, each substance is *positive* to all below, and *negative* to all above it, two being used together.

Bismuth.	Cobalt.	Brass,	Charcoal, }
Mercury, }	Silver,	Copper,	Plumbago, }
Nickel, }	Tin,	Gold,	Iron, }
Platina,	Lead,	Zinc.	Arsenic, }
Palladium.	Rhodium.		Antimony.

Annals of Phil. vol. vi. p. 170, *N. S.*

ELECTRO-MAGNETISM.

12. *New Phenomenon in Electro-Magnetism.*—Sir H. Davy found, that when two wires were placed in a basin of mercury, perpendicular to the surface, and in the voltaic circuit of a battery, with large plates, and the pole of a powerful magnet held

either above or below the wires, the mercury immediately began to revolve round the wire as an axis, and with a highly increased velocity when the opposite poles of two magnets were used, one being above, and the other below. Masses of mercury, several inches in diameter, were set in motion, and made to revolve in this manner, whenever the pole of the magnet was held near the perpendicular of the wire; but when the pole was held above the mercury between the two wires, the circular motion ceased; and currents took place in the mercury in opposite directions, one to the right, and the other to the left, of the magnet. Sir Humphry next inverted the form of the experiment. He took two copper-wires of about $\frac{1}{6}$th of an inch in diameter, the ends of which were flat, and carefully polished, and passed them through two holes 3 inches apart in the bottom of a glass basin, and perpendicular to it. They were cemented into the basin, and made non-conductors by sealing-wax, except at the polished ends. The basin was then filled with mercury to the height of $\frac{1}{11}$th of an inch above the wires. The moment the contacts were made, the mercury was immediately seen in violent agitation; its surface became elevated into a small cone above each of the wires; —waves flowed in all directions from these cones, and the only point of rest was apparently where they met in the centre of the mercury between the two wires. On holding a powerful magnet some inches above one of the cones, its apex was diminished and its base extended: by lowering the pole farther these effects were increased, and the undulations became feebler; and at a smaller distance, the surface of the mercury became plain, and rotation slowly commenced round the wire. The elevations and depressions in some experiments were $\frac{1}{5}$th or $\frac{1}{6}$th of an inch. —See *Phil. Trans.* 1823, p. 156.

METEOROLOGY.

13. *Mean Temperature of London for* 1822.—It appears from the Meteorological Journal kept in the Royal Society's apartments, and just published, that the mean temperature of London by Six's thermometer is 55° Fahrenheit, and by observations made at 8 A. M. and 2 P. M. that it is 53°.8, results which appear to be perfectly irreconcilable with one another, unless by supposing either great errors of observation, or great

defects in the instruments employed. As observations made at 8 A. M. give nearly the mean temperature of the day, and as observations made at 2 P. M. give a temperature very much higher than the mean, it is clear that the mean of these must give a result far too great for the mean temperature; that is, 53°.8, upon the supposition of the correctest instruments and the correctest observations, is far above the mean temperature of 1822. This, then, being quite demonstrable, how comes it that the self-registering thermometer of Six, which gives the daily *maximum* and *minimum* (the mean observations of which is nearer the mean temperature than 8^h and 2^h), should give for the mean temperature 55°? This observation merits the particular notice of those immediately interested in the correctness of the Royal Society's observations.—The mean height of the barometer for 1822 was 29°.863, and the quantity of rain 18.068 inches. See *Phil. Trans.* 1823, Part I.

14. *Mean Temperature of the Canaries.*—The following are the mean monthly temperatures of St Croix, at Teneriffe, in W. Long. 16° 16′ 48″, and N. Lat. 28° 28′ 30″, according to the accurate observations of Don Francisco Escolar.

Jan.,	17°.69 Centig.	May,	22°.29	September,	25°.24
February,	17 .94	June,	23 .27	October,	23 .70
March,	19 .54	July,	25 .15	November,	21 .35
April,	19 .62	August,	26 .05	December,	19 .06

The mean of these is 21°.74. Hence we have

Mean temperature of St Croix, . . .	71°.91 Fahr.
Do. calculated by Dr Brewster's formula, (86°.3 sin D)—3¼,	71 .13
Difference,	0 .78

15. *Temperature of the Springs on Ben Nevis.*—A young friend communicated to us the following notice in regard to the temperature of the springs of Ben Nevis, and which agree in a general way with those we have made on that celebrated mountain. He examined four of the springs; but as one of them ran near the surface of the ground for a considerable distance before it made its exit, he did not record its temperature. Of the other three, one was about 1200 feet from the base, another about 2000 feet, and the third was the well near the summit. When he left Fort William the thermometer stood in the shade at 56°

(8 A. M.); at the spring 1200 feet from the base, it stood at 48°, and in the spring at 41°.5. At the second spring, elevated about 2000 feet, the temperature of the air was 47°, of the water 38°; and the temperature of the third spring 36°, while that of the surrounding air was 46°.

16. *Great Heat at New South Wales.*—Dr Winterbottom informs us, that a particular friend, and a very careful observer, saw the thermometer rise, at New South Wales, to 112°, and continue so nearly a week *. The effects of this heat upon the human body were extremely distressing, producing extreme languor, and incapability of exertion. A gentleman remarkably robust and active, out of bravado, to show that he could do what not a man in the colony dared to attempt, took his gun, and went out in pursuit of game; but he was very soon obliged to return, and found some difficulty in doing so. They both described this degree of heat to be so excessive, as to give them a conviction of not being able to support a temperature of only a few degrees higher. The effects of this heat upon animals was such, that the parroquets dropped down dead in the open air. In Africa, where Dr W. resided four years, he once observed the thermometer stand at 103° in the shade, and placed upon the ground (speaking from memory) at 138°. In the Soosoo Country, to the N. of Sierra Leone, at a considerable distance inland, he walked one day about twenty miles, when the thermometer, observed by Dr Afzelius, at present Professor of Botany at Upsal, stood at 99½° in the shade; which degree of heat was by no means disagreeable, nor even suspected to be so great by at least 10°, owing to a pleasant breeze which met him. We judge very inaccurately of heat by our feelings, and are more affected by a sudden diminution of 10° of heat than by a much greater increase. The lowest degree of heat Dr W. ever witnessed in Africa was about half an hour before sun-rise, when the mercury stood at 68°, and to the feelings, the cold resembled

* We strongly suspect some error in this observation. It stood at 96° at Hobart Town on the 3d February 1822, but never rose above 90° during the rest of the year. At Macquarrie Harbour the maximum was 94° on the 1st January 1823; and during Oxley's expedition, the highest seems to have been 81°.

that of a sharp frosty morning in England. In an account of Sierra Leone, published a few years ago, is contained a few Observations upon the Seasons, &c., the accuracy of which may be relied on.

17. *Results of a Series of Hydro-thermometrical Observations made in the Frith of Forth.*—It is necessary for me to state, in the first place, that the observations from which these results were extracted, were made at the request of a friend in Leith, to whom I am indebted for the use of the thermometers, and also for much valuable information on this interesting subject. The observations were made with every possible care, and with as much regularity as my other affairs would admit of. The following are the Results of my endeavours to investigate this branch of Natural History.

1*st*, The greatest difference in temperature between the air and surface-water, observed during the whole series, was +3°.5 and —9°.0 *. 2*d*, Between the 28th of July and the 29th of August, the mean temperature of the air and surface-waters was + 3°.0 and — 6°.33. The range of the thermometer in the air was observed to be, during that period, between 62°.5 and 47° = 15°.5. The mean temperature of the surface-water 53.10, and that of the air 54°.95. 3*d*, In the month of September, the mean difference of the temperatures of the air and surface was + 2°.58, and — 3°.59. The range of the thermometer in the air during the month was between 61° and 46° = 15°, and at the surface between 56° and 51° = 5°. The mean temperature of the air 54°.26, and that of the surface-water 52°.99. 4*th*, In the month of October, the mean difference in the temperatures of the air and surface-water was + 4° and — 2°.87. The range of the thermometer in the air during the month was between 53°.0 and 39°.0 (=14°.0), and at the surface between 51° and 45°. The mean temperature of the air 46°.34, and that of the surface-water 47°.67. 5*th*, That although the temperature of the air has on some days varied 10°, that of the surface-water, on the same day, has not altered more than 1°, or 1°.5, and

* By the sign + it must be understood that the water was warmer than the air, and — the contrary.

sometimes has been quite stationary. With respect to the temperature below the surface, I have every reason to believe it to be the same as the surface-water (at least at such inconsiderable depths as occur in the Frith), and what little difference the Register Thermometer has given, I rather suspect, has proceeded more from some undue movement in the index than from any real change in the temperature of the water.—JOHN FREMBLY, R. N. *Assistant Maritime Surveyor of his Majesty's Surveying Brig Investigator.*

18. *Temperature of the Caribbean Sea at great Depths.*—On the 13th November 1822, in W. Long. 83½°, and N. Lat. 20½°, between Grand Cayman Island and Cape St Antonio, Captain Sabine found that the temperature of the sea, at a depth of *six thousand* feet, was 45°.5 of Fahrenheit, the temperature at the surface being 83°. The difference of temperature was therefore 37°.5. M. Perron had formerly found this difference to be 38° in 5° of N. Lat. and at a depth of 1200 feet, and 42 in N. Lat. 4°, at a depth of 2144 feet. Captain Sabine used Six's registering thermometer, made on purpose for the experiment. —See *Phil. Trans.* 1823, pp. 288, 289.

II. CHEMISTRY.

19. *Determination of the Masses of the Molecules of Bodies.*—A very elaborate memoir on this subject, entitled *Nouvelles Considerations sur la Theorie des proportions determinées dans les combinaison, et sur la determination, des Masses des Molecules des Corps,* has just been published by the Chevalier Avogrado, in the *Memorie della Reale Academia delle Scienze di Turino,* tom. xxvi. p. 1. As it occupies no less than 162 pages, we cannot pretend to give any thing like an analysis of it. The Chevalier Avogrado has already published his general views on the subject in the *Journal de Physique* for July 1811, and February 1814. In the first part of the present paper, he resumes the consideration of these, and in the second part he treats of the masses of the molecules of particular substances, and of their binary combinations. The following are the principal results, which we have gleaned from different parts of the memoir.

Substances.	Mass of the Molecules, that of Oxygen being taken at unity.	Mass of the Molecules, that of Hydrogen being taken at unity.
Hydrogen,	0.0624	——
Oxygen	——	16.026
Water,	1.1248	18.026
Azote,	0.878161	13.9733
Chlorine,	2.2535	36.124
Carbon,	0.75392	12.0823
Sulphur;	2.2447	32.683
Fluorium,	1.125	18.000
Borium,	0.921	14.700
Potassium,	4.89915	78.400
Sodium,	5.8184	93.000
Calcium,	5.1206	82.000
Magnesium,	6.3344	101.300
Borium,	17.1386	274.000
Strontium,	10.946	175.000
Silicium,	1.9761	31.600
Aluminum,	2.2822	36.200
Mercury,	25.316	405.000
Silver,	13.51605	216.000
Gold,	24.86	398.000
Platina,	24.30452	389.000
Lead,	25.8900	414.000
Iron,	6.7843	108.500
Copper,	7.9139	127.000
Manganese,	7.11575	114.000
Tungsten,	24.15378	386.000
Zinc,	8.0645	129.000
Molybdena,	5.968	95.500
Antimony,	8.0645	129.000
Arsenium,	4.70385	75.000

20. *Application of the Theory of Determinate Proportions to Organic Compounds.*—The Chevalier Avogrado has published in the same volume of the Turin Memoires, p. 440–507, a memoir entitled *Sur la maniere de ramener les composés organiques aux loix ordinaires des proportions determinées.* In this able memoir, which is unsusceptible of abridgment, he treats of binary, ternary, aud quaternary combinations, viz. those formed either of carbon and hydrogen, such as naphtha; or carbon, hydrogen, and oxygen, such as sugar, alcohol, ether, and most substances of vegetables; or carbon, hydrogen, oxygen, and azote, such as fibrine, usus, uric acid, &c.

21. *Simple Method of liquefying the Gases.*—Sir H. Davy has recently used a very simple method of liquifying the gases by the application of heat. It consists in placing the gas in one leg of a bent sealed tube confined by mercury, and applying

heat to *ether*, *alcohol*, or *water*, in the other end. In this way, by the pressure of the vapour of ether, he liquified *prussic gas*, and *sulphureous acid gas*. When these gases were reproduced they occasioned cold.—See *Phil. Trans.* 1823, p. 203.

22. *On the Expansion of Gases of different densities by Heat.*—In order to determine the law of expansion of gases of different densities, Sir H. Davy included dry atmospherical air in a tube of mercury, and having raised its temperature from 32° Fahr. to 212°, he marked its expansion. The same volume of air, but of double and of more than triple the density under a pressure of 30° and 65 inches of mercury, were heated in the same manner and in the same tubes, and when the necessary corrections were made for the difference of pressure of the removed columns of mercury, it was found that the expansions were exactly the same. Sir Humphry next constructed an apparatus, in which the expansion of rare air confined by columns of mercury were examined and compared with the expansion of equal volumes of air under common pressure; and he found, that, for an equal number of degrees of Fahrenheit's scale, and between 32° and 212°, the expansions were precisely equal, whether the air was *one-half*, *one-third*, or *one-sixth* of its natural density. Similar results were obtained with air *condensed six*, and *expanded fifteen*, *times*.—*Phil. Trans.* 1823, p. 205.

23. *On Bitumen in Stone.*—The Right Honourable George Knox, whose experiments on the subject we slightly noticed in our last, has subjected various minerals to distillation, for the purpose of obtaining their volatile ingredients. He obtained

From Arran Pitchstone, -	2	per cent. of Bitumen.
	2.5	of Water.
Pearlstone, - -	2.5	Do. and floating Bitumen.
Basaltic Greenstone, -	1.75	Pure Bitumen.
Amygdaloid, - -	3.1	Bituminous Water.
Wacke from Disco Island,	11.42	Do., 4 cubic inches of Carbonic Acid, and 8 of carburetted Hydrogen.
Iron-clay from Howth, -	4	Bitumen.
Hornblende, - -	0.75	Bituminous Water.
Tourmaline, - -	0.7	Ditto.
Augite, - -	0.35	Bitumen.
Serpentine, - -	10.5	Bituminous Water.
Clay-slate, - -	3.0	Ditto.
White Felspar. - -	0.35	Ditto.

Menilite,	3.75	Ditto.
Adhesive-slate,	18.5	Water of Bitumen.
Mica,	1.33	Bituminous Water.
Pearl-white common Quartz,	0.1	Fetid Bituminous-Water.
Carrara Marble,	0.1+	Water.
Lucullite,		Traces of.
Obsidian,	0.2	Bituminous Water.
Amygdaloid,	3.1	Ditto.
Bole,		Considerable ditto.

Ammonia was found in many cases, but Mr Knox considers it as a *product* and not an *educt*, arising from the decomposition of the bitumen, either by the iron of the retort, or the carbon of the stove at a high temperature. In these distillations a matter often condensed in the retort, which was exceedingly volatile, and which was easily raised in vapour by the heat of the hand. Mr Knox concludes by recommending to chemists a previous distillation in all analyses of stony substances, in order to obtain the liquid bitumen, and also the carbon which has escaped in the shape of gas; and also that the residuum in the retort should be afterwards examined for the remaining carbon, either by burning it off, or in such other manner as may seem best to the operator. —See *Phil. Trans.* 1823, p. 517–528.

24. *Composition of James's Powder.*—Mr Phillips has found James's powder from Messrs Newberry, to consist of

Peroxide of Antimony,	56.0
Phosphate of Lime,	42.2
Oxide of Antimony, impurity and loss,	1.8
	100.0

Ann. of Phil. v. i. 1819. *N. S.*

25. *Gold crystallised from its solution in Sulphuric Ether.*—Having allowed a solution of gold in sulphuric ether to stand *four* years in a vessel, with a cork and a piece of leather tied over it, Mr Sivright found that a great part of the liquid had evaporated, leaving the gold in the form of a thin plate, which has the usual brightness of pure gold, and resembles the flat pieces of native copper found in Cornwall. There were distinct crystals in one or two parts of the plate.

26. *On the Fusion of Plumbago and Charcoal.*—As the experiments of Professor Silliman, which we have given in our

two last numbers, have excited much interest, we shall lay before our readers the following observations which have been previously made on the subject, and which have been sent us by a correspondent. "Carbon, says Sir H. Davy, whether coherent as charcoal, or in powder, is infusible by any heat that has hitherto been applied. I have exposed it to the powers of intense ignition of different voltaic batteries; that of Mr Children, mentioned page 151., one of 40 double plates 18 inches square, and the battery of 2000 double plates, both in vacuo and in the compressed gases, on which it had no power of chemical action. A little hydrogen was given off from it; it slowly volatilized in these experiments, and the part remaining was much harder than before, so as in one case to scratch glass; the lustre was greater; but its other properties were unaltered; there was no appearance of fusion." Dr Clarke exposed a diamond of 6 carats, of an amber colour, to the flame of the gas blowpipe. It became colourless and transparent,—after this it became white and opake, and by continuing the heat, it was entirely volatilized in about three minutes. Glance-coal from the Calton Hill, according to Mr Sivright's experiments, when heated in the focus of an 18 inch silvered mirror, was slowly volatilised, but there was no appearance of fusion. The substance found under the gas retorts was volatilized in the same way with a slight smell of ether, but it was not fused. Dr Clark says, that the fusion of plumbago with the gas blowpipe was attended with a vivid scintillation. The surface was covered with a number of minute globules; some of which exhibited a limpid and highly transparent glass, others a glass of a brown hue; the larger globules being jet black and opake, with a dark metallic lustre. With the common blowpipe, Mr Sivright found that black globules were formed on the surface of plumbago, but no transparent ones. In the focus of the mirror it became brown, with small white specks and black globules on its surface. The globules are probably an iron slag. They are hard enough to scratch glass. The white specks are perhaps silica, or some earth which the heat obtained in this way is not sufficient to fuse.

27. *Cagnard de la Tour's Experiments on the Vaporisation of Fluids.*—In our last volume, p. 199, we gave a general notice of these curious experiments. M. Cagnard de la Tour has

prosecuted the subject to a greater length, and obtained several interesting results. When one of his tubes, containing water and a little sulphuret of carbon was heated, the water became at first milky, then transparent, with a slight green tinge, and afterwards almost black by increasing the temperature. The sulphuret of carbon became lighter than the water during the experiment, and floated on it some time before it became all vapour. As the tube cooled, the green colour diminished, and the fluids took their first state, the water having a yellowish tinge. When a little chlorate of potash was put into the tube along with the above fluids, the heat first dissolved the salt; but upon cooling, the water became milky, and the floating sulphuret of carbon fell to the bottom with the crystallizing salt. At a higher heat, the liquor became suddenly of a pure lemon-yellow colour, accompanied with effervescence, and the formation of an oily-looking globule; which, on cooling, remained liquid at the bottom of the tube, without any crystals being formed. With a still higher heat, the yellow liquid disappeared, and was replaced by a small globule of liquid sulphur, which, by additional heat, assumed the colour and transparency of ruby, but resúmed the appearance of sulphur by cooling. No trace of sulphuret of carbon appeared in the tube, excepting that, at a certain heat, the water became bluish, though it was always colourless when cold. This coloration did not appear in another tube, where the proportion of chlorate of potash was greater. Small acicular crystals sometimes formed in these tubes in groups of five or six about a central point; and once the whole mass was crystallized. When the water was alone, the transparency of the glass was always affected, but never along with other substances. The sulphuret of carbon goes into vapour at 220° of Reaumur, the proportion of fluid to the contents of the tube being as 8 to 20. It then exerts a pressure of 77.8 atmospheres, the pressure gradually increasing with the heat both below and above 220°. The following results were obtained with Ether, when the volume of liquid was 7, and that of the tube 20.

Temp. Reaumur.		Pressure in Atmospheres.	Temp. Reaumur.		Pressure in Atmospheres.
80°	.	5.6	180	.	68.8
100	.	10.6	200	.	86.3
120	.	18.0	240	.	119.4
Into vapour at 150	.	37.5	260	.	130.9

When the volume of ether was $3\frac{1}{2}$, and the tube 20, he obtained the following results.

Temp. Reaumur.		Id. Atmospheres.	Temp. Reaumur.		Id. Atmospheres.
100°	.	14.0	160	.	50.5
120	.	22.5	180	.	63.5
130	.	28.5	200	.	70.5
140	.	35.0	230	.	81.0
Into vapour at 150	.	42.0	260	.	94.0

III. NATURAL HISTORY.

MINERALOGY.

28. *Characters of Amber.*—1. Amber has never the lengthened or drop-form of the gum animi, or other substances with which it may be confounded. 2. Amber has always a richer colour than the resins, &c., which are comparatively watery, thin, and feeble in colour. 3. It has a peculiar lustre, indicating a higher refractive power than resins, &c. * 4. Amber, on rubbing, gives out a different smell from the resins, with which it might be confounded. 5. Both resins and amber are electric. 6. If the specimen is held against a red-hot iron, the smell of the smoke will distinguish it from the resins or gum animi, gum opal, &c. 7. Haüy's Drop Character is not good.

29. *Rose on Felspar, Albite, Labradorite, and Anorthite.*—M. Gustavus Rose of Berlin, has published a highly interesting and elaborate paper, in the *Annalen der Physik*, &c. of Gilbert, for February 1823, on the substances formerly comprised under the name of Felspar, which he divides into four species, viz. Felspar, Albite, Labradorite, and Anorthite, differing from each other in their form, and in several other characters, as also by the results of their chemical analysis.

* Amber has a lower refractive power than several of the gums.—Ed.

The most remarkable differences are contained in the following Table:—

Forms in General.

Felspar.	*Albite.*	*Labradorite.*	*Anorthite.*
Bino-unitary.—*Weiss.* Hemi-prismatic.—*Mohs.*	Unitary. *Weiss.* Tetarto-prismatic.—*Mohs.*	Unitary. *Weiss.* Tetarto-prismatic.—*Mohs.*	Unitary. *Weiss.* Tetarto-prismatic.—*Mohs.*

Measures of the principal Angles, referring to the figures of Haüy.

	Felspar.	*Albite.*	*Labradorite*	*Anorthite.*
P to M,	90° 0′	93° 36′	Nearly 93½°	94° 12′
P to *l*,	112 1	110 51	——	——
P to T,	112 1	115 5	——	110 57
l to M,	120	119 52	——	122 2
T to *l*,	120	122 15	——	120 30
T to M,	120	117 53	——	117 28
	Weiss.	*Rose.*	*Rose.*	*Rose.*

Specific Gravity according to Rose.

Felspar.	*Albite.*	*Labradorite.*	*Anorthite.*
From 2.394, To 2.581.	From 2.608, To 2.619.	From 2.695, To 2.7025.	From 2.656, To - 2.763.

Chemical Characters calculated according to Formulæ established by experiment.

	Felspar.	*Albite.*	*Labradorite* from Labrador, by *Klaproth.*	*Anorthite* from Monte Somma, by *Rose.*
Silica, -	65,94	69,78	55,75	44,49
Alumina, -	17,75	18,79	26,50	34,46
Potash, -	16,31	——	——	——
Soda, -	——	11,43	4,	——
Lime, -	——	——	11,	15,68
Oxide of Iron,	——	——	1,25	0,74
Water, -	——	——	0,50	——
Magnesia,	——	——	——	5,26
	100.00	100,00	99,00	100,63

Mr Rose has given the following chemical formulæ along with the analyses.

Felspar,	. .	$KS^3 + 3\,AS^3$
Albite,	. .	$NS^3 + 3\,AS^3$
Labradorite,	.	$NS^3 + 3\,CS^3 + 12\,AS$
Anorthite,	. .	$MS + 2\,CS + 8\,AS$

Of these, Felspar is said to occur most commonly; Albite, besides the Swedish localities, is mentioned from Arendal, from several places in the Alps, from Kerabinsk in Siberia, Scotland, &c.; Labradorite is noticed from the coast of Labrador, and from Ingria; Anorthite has hitherto been found only in blocks of limestone from Monte Somma.

We understand that almost a year before the publication of this paper, M. Mohs and M. Haidinger had obtained nearly the same results as to the differences prevailing among the forms, specific gravity and other properties of these substances, and considered them accordingly as different species (*Edinburgh Philosophical Journal*, No. XVI. p. 287.), with the exception only of Anorthite. But they observed some difference in the angles of certain tetarto-prismatic varieties from the Alps, and in their specific gravity, which is between 2.5 and 2.6, and very likely may lead to the establishment of another species. The last of these is probably the same as that which has been observed by M. Breithaupt of Freyberg, in some varieties from Töplitz, in Saxony, and of which he intends to give a full description in a particular paper on these substances. Messrs Brooke, Levy, and Phillips, have likewise ascertained the difference between some of the above mentioned species; and Mr Brooke has given the name of Cleavelandite to what formerly had been called Albite. From the united labours of so many mineralogists, directed towards the same object, we may expect in a short time to become more intimately acquainted with these substances; and we are perfectly convinced, that it would be a matter of the highest importance to join with these inquiries such as are directed towards their optical properties.

ZOOLOGY.

30. *The Woodcock.*—Our friend Major Morison remarks in a letter to us, that there are "few birds among the migratory class, whose character, under this head, invites a greater field for specu-

lation than the Woodcock. Previous, however, to my advancing reasons for such an opinion, I beg to communicate the account which is given of the woodcock in Bewick's History of Birds. —"'It is said to inhabit every climate; it leaves the countries bordering upon the Baltic in the autumn and setting-in of winter, on its route to this country. They do not come in large flocks, but keep dropping in upon our shores singly, or sometimes in pairs, from the beginning of October till December. They must have the instinctive precaution of landing only in the night, or in dark misty weather, for they are never seen to arrive; but are frequently discovered the next morning in any ditch which affords shelter, the more particularly after extraordinary fatigue occasioned by the adverse gales, which they often have to encounter in their aerial voyage. They do not remain near the shore, to take their rest, longer than a day, but commonly find themselves sufficiently recruited in that time, to proceed inland, to the very same haunts which they left the preceding season."—Two cases are advanced in support of this last assertion; the first is, that, in the winter of 1797, the gamekeeper of E. Pleydell, Esq. of Whitcombe, in Dorsetshire, brought him a woodcock, which he had caught in a net set for rabbits, alive and unhurt. Mr Pleydell marked the date upon a small piece of thin brass, bent it round the woodcock's leg, and let it fly. In December in the next year, Mr Pleydell shot this bird, with the brass about its leg, in the very same wood where it had been first caught by the gamekeeper. The second case is that of a white woodcock having been seen three successive winters in Penrice Wood, near Penrice Castle, Glamorganshire. It was repeatedly flushed and shot at during that time, in the very same place where it was first discovered. At last, it was found dead, with several others, which had perished by the severity of the weather in the winter of 1793.—In further proof of the woodcock returning to its former haunt, I have to state, that one was seen in Ireland some years ago, of a slate-colour, on a particular estate, three successive winters; its existence, however, was not prolonged from a succession of unfortunate shots, as mentioned of the bird in Wales, but from a very different cause. The proprietor of the spot which this woodcock had chosen for its retreat, was a sportsman, and meet-

ing with it early in the first season, was surprised with its peculiar colour, and aware of this species of bird being attached, like the swallow, to particular places, was desirous of preserving it, which wish he had made known in the neighbourhood; but at last, a stranger from a distance, who had not heard of the wished-for exception, approaching the bird's retreat, effected its destruction. The inhabitants on the east coast of England are decidedly of opinion, that the woodcocks come from the eastward; while those on the west coast are equally positive these birds come from the westward. This is a point it may be difficult to determine; certain it is, however, that whencesover they may come, their condition on their appearance in the autumn, is invariably such as strongly to indicate that the countries they left are remotely situated. Previous to the arrival of the woodcocks in Cornwall, they are met with in numbers in the Scilly Islands, which are situated seventeen miles to the westward of the Lizard; and where, at the commencement of the season, they are in such an exhausted state as to be easily caught. They so regulate their flight, that their approach to those islands has never been observed,—their descent must, therefore, occur by night; their stay at the Scilly Islands does not exceed the day, and on the approach of night, they again take flight to the eastward. There is a light-house among the Long-Ships, a reef of rocks so called, situated about two miles to the westward of the Land's-End; and it frequently happens in the month of October, that woodcocks are found dead under the strong glass that protects the light: the birds during the night having been attracted by the brilliant glare, and flying against the glass with great force, are instantly killed; and as this circumstance occurs on the west side of the light-house, it is advanced among other reasons in support of the assertion, that the woodcocks come from the westward. It is not, however, the particular direction of the woodcock on its approach to our shores; but the great distance of its flight which creates astonishment, especially in those who are familiar with this bird, from its efforts when disturbed, appearing so ill suited to a long or protracted flight: the surprise may still be heightened by the circumstance, that amidst the great number of birds of the migratory class, which have, in a truly exhausted state, taken refuge on the masts, rigging, and

decks of ships at sea, I have not been able to trace a single instance, either of a woodcock having recourse to such an aid, or that it has been enumerated among the thousands of birds that have from time to time been found drowned on the shores of the ocean. Further, the period for the appearance of the woodcock in England, does not seem to be retarded by either a long series of calm, moderate, or tempestuous weather, or from the long prevalence of the wind in any particular quarter: hence it may be inferred, that the woodcock is favoured by nature with an instinct peculiar to its species; which, during its transit from one country to another, however distant, insures its safety. This may give some weight to the hypothesis of the existence of currents in the higher regions of the atmosphere, which set in the direction convenient for the transport of the woodcock, both in its approach and retiring from this island; and that the extraordinary instinct to which I have alluded, enables this bird in the outset to soar to such a height as to avail itself of their influence; which being gained, it is conveyed away with a rapidity of which we may form some idea, when the fact is stated, of balloons being propelled or hurried along from forty, to a rate exceeding eighty miles an hour. The great accuracy with which the woodcock is enabled to drop on an island, (however small), in the ocean, at a great distance from the main land, and in the darkest night, may proceed from the marked change in the air over the land which the bird feels even at an immense altitude."

IV. GENERAL SCIENCE.

31. *Chinese Year.*—Mr Davis has shewn that the Chinese year is a lunar year, consisting of 12 months of 29 and 30 days alternately, with the triennial intercalation of a thirteenth month, or rather an intercalation seven times in nineteen years, to make the year correspond more nearly with the sun's course. It has not been ascertained why they fix upon the 15th degree of Aquarius as a rule for regulating the commencement of their lunar year; but they have an annual festival about the recurrence of this period, which resembles the deification of the bull Apis. See *Phil. Trans.* 1823, p. 94.

32. *Introduction of Vaccination into China.*—Mr Davis, in the paper just quoted (p. 92), mentions the following curious

fact. When Dr Pearson made the Chinese his invaluable present of the vaccine inoculation, it was accompanied by a small pamphlet, in Chinese, containing a few necessary directions as to the use of the virus, and stating the discovery to have been English. A *purified* edition of this little book was very soon after published, in which not one word was retained as to its origin, nor any trace by which it could be known that the discovery of vaccination was otherwise than Chinese.

33. *Cutting of Steel by Soft Iron.*—The very remarkable experiment on this subject which we described in our last Number, p. 409., has been successfully repeated by Mr Perkins. A piece of large hard file was cut by him into deep notches by the burr of soft iron. When the burr was applied against the flat surface of the file, the teeth were removed without any sensible elevation of the temperature of the metal. The burr was not reduced in size or weight, but had acquired a very hard surface at the cutting part.

34. *Granite for London Bridge.*—As this grand national work is about to be erected, a considerable discussion has arisen respecting the materials of which it is to be built. It is agreed on all hands that the stone must be *Granite*; and that the granite employed must be the strongest in Great Britain. In an article in the *Journal of the Royal Institution*, Vol. XVI. p. 30. it is taken for granted that the Cornish granite is to be used; but the writer of that article, when he made this supposition, was certainly not aware of the interesting experiments of Mr George Rennie, on the strength of the granite from Aberdeen, published in the *Philosophical Transactions* for 1818, p. 131, 132. In that paper, which the anonymous writer quotes, Mr Rennie states, that a $1\frac{1}{2}$ inch cube of Cornish granite is crushed with a force of 14,302 lb. avoirdupois, whereas it required 24,556 lb. avoirdupois to crush a similar cube of Aberdeen granite. Mr Rennie found also, that the Aberdeen granite possessed the valuable property of being lighter than the Cornish granite, the specific gravity of the former being 2.625, and that of the latter 2.662. Hence it may be shewn, that a pillar of Cornish granite will crush at its base, if its height is 5498 feet, whereas a pillar of Aberdeenshire granite will not crush at its base till it reaches the enormous height of 9600 feet. In con-

sequence of this decided superiority of Aberdeen granite, the arch-stones of the Bridge of Aberdeen, built of Aberdeen granite, have only about *one-half* the depth of the arch-stones of the Strand Bridge built of Cornish granite, although the span of the arch in the former is about 10 feet wider than the span of the arch in the latter. The Committee of Management of the London Bridge has advertised for specimens of Granite from different parts of the kingdom, and their relative strengths are to be determined by the Royal Society of London.

ART. XXXII.—*List of Patents granted in Scotland from 8th August to 4th December* 1823.

21. TO JOHN BUTLER and ELLIS GLEEAVE, of Manchester, in the county of Lancaster, machine-makers, and partners in business, for " a new machine-engine, or mechanical contrivance, for feeding or supplying steam-boiler furnaces, or other furnaces, with coals, cokes, or other fuel, by machinery, whereby the quantity of smoke proceeding therefrom is greatly reduced, and a great saving is effected in the quantity of fuel consumed, and in the labour necessary for feeding and supplying the same therewith." Sealed at Edinburgh 28th August 1823.

22. To THOMAS LEACH, of Friday Street, London, merchant, for " improvements in certain parts of the machinery for roving, spinning wool, cotton, silk, flax, and all other fibrous substances." Sealed at Edinburgh 6th September 1823.

23. To THOMAS HANCOCK, of Goswell, Parish of St Luke's, Old Street, county of Middlesex, patent cork-manufacturer, for " an improvement in the preparation of various useful purposes of pitch and of tar, separately or in union, by an admixture of other ingredients with either or both of them." Sealed at Edinburgh 5th September 1823.

24. To ARCHIBALD BUCHANAN, of Catrine Cotton-Works, one of the partners of the house of James Finlay and Co. merchants in Glasgow, for " an invention of an improvement in the construction of weaving-looms, impelled by machinery, whereby a greater quantity of cloth may be weaved in a given time, without injury to the fabric, than by any application of power for that purpose heretofore employed." Sealed at Edinburgh 10th October 1823.

25. To Matthias Archibald Robinson, of Red-Lion Street, Parish of St George the Martyr, county of Middlesex, for "certain improvements in the mode of preparing the vegetable matter commonly called Pearl Barley, and Gritts or Groats, made from the corns of barley and oats, by which material, when so prepared, a superior mucilaginous beverage may be produced in a few minutes." Sealed at Edinburgh 2d Oct. 1823.

26. To John Henfry, of Little Henry Street, Waterloo Road, county of Surrey, engineer, and Augustus Applegath, of Duke Street, Stamford Street, Blackfriars, county of Surrey, printer, for "invention of certain machinery for casting types." Sealed at Edinburgh 17th October 1823.

27. To William Robson, of St Dunstan's Hill, Tower Street, London, printer and stationer, for "a method to prevent or protect against, fraudulent practices upon bankers' checks, bills of exchange, and various species of mercantile, commercial, and other correspondence." Sealed at Edinburgh 17th October 1823.

28. To Joseph Johnston, of Waterloo Bridge Wharf, county of Middlesex, for "certain improvements on drags to be used for carriages." Sealed at Edinburgh 17th October 1823.

29. To Joshuah Taylor Beale, of Christian Street, St George's in the East, cabinet-maker, and Thomas Timothy Benningfield, of White-Chapel, High Street, county of Middlesex, tobacco manufacturer, for "certain improvements in steam-engines." Sealed at Edinburgh 23d October 1823.

30. To Charles Anthony Deane, of Charles Street, Deptford, in the county of Kent, ship-caulker, for "an apparatus or machine to be worn by persons entering rooms or other places filled with smoke or other vapour, for the purpose of extinguishing fire, or extricating persons or property therein." Sealed at Edinburgh 4th December 1823.

31. To Francis Gybbon Spilsbury, of Walsall, county of Stafford, for "certain improvements in tanning." Sealed at Edinburgh 4th December 1823.

32. To Joseph Rogerson Coller, of Castle-Magna, near Mallow, in the county of Cork, clerk, for "certain improvements in wind musical instruments." Sealed at Edinburgh 4th December 1823.

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THE

EDINBURGH PHILOSOPHICAL JOURNAL.

ART. I.—*On an apparent Paradoxical Galvanic Experiment.*

* By J. C. OERSTED, Professor of Chemistry and Natural Philosophy in the University of Copenhagen, and F. R. S. E. Communicated by the Author.

IN a Memoir, published some months ago, by M. Von Moll, at Utrecht *, this philosopher (already known from various experimental researches) describes an experiment, which, at first sight, appears to indicate a new class of galvanic phenomena.

I have submitted this experiment to an attentive examination. Fig. 1. of Plate VII. is the apparatus of M. Von Moll. ABCD is a perpendicular section of a plate of zinc, bent in such a way that its extremities touch, and form a closed circuit. NS is a magnetic needle, properly suspended. The part A of the circuit is plunged in acidulated water.

If any point of this circuit under the water be touched by a piece of brass, the motion of the needle indicates an electric current. In order to be certain that the metallic continuity was not interrupted by the interposition of a part of the fluid, I substituted for that in Fig. 1., the circuit ABCDE, Fig. 2., cut out of a plate of zinc. The effect described by the Dutch philosopher was produced by this circuit likewise; but I soon discovered that it was owing to the ordinary galvanic circuits, like that formed by the copper GH, the zinc GA, and the fluid be-

* *Edinburgh Phil. Journal*, vol. ix. p. 167.

tween H and A, or, as in that in Fig. 3. formed by the copper JK, the zinc KC, and the fluid.

The contact of the copper and zinc above the water, or at the surface of the water, produces no effect. In order to make myself sure that a collateral galvanic circuit was capable of producing such an effect on a homogeneous metallic circuit, I made the construction shewn at Fig 4., in which ABCDE is the same homogeneous circuit as before, but JGF is an arch of copper, in contact with the zinc at J, and separated from it at F by a fold *h k* of paper wetted in acidulated water. In alternately opening and closing this circuit, I found that the needle moved as in the preceding cases. This construction may therefore be considered as composed of a galvanic circuit JGFJ, and a conductor JCDEBAF, which transmits a current similar to that transmitted by JGF.

This explanation is confirmed by an experiment made with the construction represented in Fig. 5. in which ZZ is a plate of zinc, CCCC a plate of copper, and AA a vessel of acidulated water. When a magnetic needle is placed at NS, it is deflected according to the known laws; but, if to this circuit there be added the conductor KKK, a part of the electricity passes in it, and acts more feebly on the needle, from being at a greater distance from it. The effect of the second conductor becomes more striking when the needle is placed at *n s*, and when (after having noted its deviation) the conductor KKK is added; because, in this case, the second conductor being above the needle, tends to give it a contrary deflexion to that given by the first conductor, which is below it. These experiments have the same result when ZZ is made of copper, and CCC of zinc.

On applying all this to the constructions in Figs 2. and 3., we observe, that CDEBA is the same thing as the second conductor in Fig. 5. and that the current in the part DE (Figs. 2. and 3.) should have the same direction as in the part CA (to which it is parallel), in the same manner that the currents are similar in CCC and KKK, in Fig. 5. This being granted, we can determine the direction of the current in all the other parts of CDEBA (Figs. 2. and 3.), and experiments with the needle will confirm the predictions of the theory. In some experiments, M. Von Moll substituted a plate of zinc for the copper, with which he

touched the zinc circuit, and produced electro-magnetic effects by these means also. This is likewise reducible to a collateral galvanic circuit; for I have proved, by experiments published two years ago, that a galvanic circuit may be made for a short space, by two plates of zinc and a liquid, provided that one of the plates be brought into contact with the liquid before the other.

ART. II.—*Remarks made during part of a Journey from Christiania to Bergen, in the Summer of* 1821. By Professor HANSTEEN *.

ON the 22d of June I went from Christiania to Kongsberg, in order to go westward into Telemarken, to visit the celebrated Riukand Fall, and the not less remarkable Gousta Field, which, so far as I know, is the highest mountain in the south of Norway. From that I intended to proceed northward through Nummedal to the borders of Hallingdal, and thence to Eidford in Bergenstift. As geographical measurements had not extended to this part of the country, I expected to find considerable inaccuracies in Pontoppidan's map, and therefore took with me a sextant, chronometer, barometer, and thermometer, to settle, so far as it might be in my power, any geographical points. I was besides interested in making some magnetical observations in the west of Norway: for the western variation of the magnetic needle is greatest towards the west, and its inclination and intensity are greatest towards the north. As experience had taught me that mountains have a certain influence on these three magnetic phenomena, I wished to examine this matter more narrowly in the mountainous district of the west. For this purpose I carried with me a small azimuth compass, an instrument for measuring the declination, and an apparatus with a pendulum for determining the strength of the magnetism of the earth at different places.

At Kongsberg, on the 23d of June, we found, by a series of observations, the latitude of the place 59° 40′ 8.8″: the chronometer gave the difference of time W. of Christiania 4′ 15¾″. The

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* Translated from the Danish.

mean of four observations by the barometer, gave the height of Kongsberg above the level of the sea at 479 Rhenish feet.

About Dunserud, which lies a Norwegian mile * on this side of Kongsberg, we begin already to enter the mountainous region; but as a good carriage road is kept for the sake of the silver-works all the way to Kongsberg, the inconvenience of mountain travelling is not felt till we are on the west side of that town. For a mile farther on, till you come to Moe, a small carriage may get on with difficulty; but the whole of the rest of the way must be travelled on horseback or on foot, and all baggage must be carried balanced on each side of a horse. To my misfortune I still kept my little car, and as my aged guide, as he has since acknowledged, had not been that way for the last forty years, he mistook the road, and while, to recover it again, he drove along foot-paths, through bushes and underwood, which threatened every moment to upset the car, or at least to tumble out the instruments, in an instant, horse and car sunk deep in a morass, from which he succeeded in getting them drawn out, after four peasants had toiled at the work for an hour and a half with all their strength.

After you come to the farm-house of Bolkesiö, you have to ascend a considerable hill, called Bolkeheia, the height of which above the sea we found to be 1763 feet. Here you are suddenly struck with the sight of an imposing range of mountains. Five different mountains, like a row of the scenes of a theatre, shew themselves in the back ground, each more distant and higher and bluer than the others. Farther back Gousta raises his majestic summit, like a sharp-pointed wedge. From this place the road again descends till you come to Tindsiöe, the height of which we found to be 612 feet.

My little adventure in the morass between Kongsberg and Bolkesiö, had detained me so long, that though, on the 24th of June, I had set out by nine in the morning, I did not reach Bolkesiö till about five in the afternoon, completely exhausted by the burning heat of the sun. At Buewater, at a height of 1471 feet above the level of the sea, the thermometer stood at 18° of Reaumur ($72\frac{1}{2}$° Fahr.), in the shade, at a quarter after

* The Norwegian mile is nearly seven English, about $6\frac{9}{10}$. *Translator.*

three in the afternoon; at Bolkesiö Heia, a height of 1765 feet, it stood at 20° (77° F.) at a quarter past four; and at Bolkesiö, a height of 1240 feet, at 19° (74¾° F.), half an hour past five*. I determined, therefore, to remain at this latter place till next morning, and to make several astronomical and magnetic observations, for which the beauty of the weather and this singularly favourable resting-place, gave me so good an opportunity. After my instrnments were unpacked and set up, young and old of both sexes, from the grandmother trembling with age to the four year-old boy, in his bare shirt, on account of the heat, crept up to the sextant, which stood on a low foot on the ground, to view the coloured images of the sun. They were particularly delighted to see these images approach one another, or separate from one another, as the sun descended. The women especially, both here and on all other occasions, broke out into repeated exclamations of wonder at this sight.

The hypochondriac inhabitant of towns, the functions of whose body are half suspended by his sedentary employment, and the vivacity of whose mind is often sunk in unsocial egotism and half cultivation, should now and then take a journey to a mountainous country. The functions of the body are not more quickened by the pure air of the mountains and the exertions of the journey, than the mind is exhilarated by the grand scenery of Nature, and the uncorrupted character of the amiable people who inhabit them. Honesty, frankness, naiveté, a good understanding, a cheerful temper, and an uncommon tact for what is becoming in conduct, are the characteristics of these children of nature. The stranger is immediately addressed with the brotherly *Thou*. Rank and titles are unknown to them. They are anxious to learn his name, especially his Christian name, and his purpose; not as a couple of foreign travellers thought, from suspicion, but because, by means of the name and other circumstances, they endeavour to fix an event interesting to them in their memory; for, in these remote regions, the arrival of a stranger is

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* I have observed here, as well as in other places, that in narrow mountain tracts, the general rule does not always hold that the heat decreases as we rise higher. This has sometimes an unfavourable effect on our barometrical measurements.

a very rare and remarkable occurrence. If you remain with them a little while, and win the mountain peasant's confidence, you will sometimes see him, at your departure, take out a little pocket-book, and insert in it the name of his guest. It was with surprise I heard several peasants in Wesfiorddal, repeat the names of Esmark, Smith, Schow, Flor and Dahl, and, in short, of all the persons who had visited Riukandfall, or ascended Gousta, while all they had undertaken was still fresh in their memories. The scarcity of incident is probably likewise the cause that the mountain peasant is commonly so much interested in the political scenes of the great theatre of Europe. After the first explanations are over, the traveller is eagerly questioned if there is any where an appearance of war. The Greeks' war of Freedom was therefore the first, and the measures of the Storthing, the second subject, which at this time were usually brought on the carpet. Many of them read carefully the newspapers, which are lent to them by the clergymen, or other official persons in the neighbourhood: they are commonly well versed in the geography of Europe, and particularly in the ancient history of their own country. Snorré Sturleson, Bastholm's Philosophy for the unlearned, and the works of several of our later popular writers, are to be found in a row on a shelf in the house.

Agriculture is here inconsiderable; and as we approach nearer the limit of snow, becomes impossible. But the more advantageous becomes the rearing of cattle. The vigorous mountain plants give the cattle a degree of fatness, which the more luxuriant grass of the lower plains cannot produce. The greater part, therefore, of the peasant's food, consists of milk. The laborious exertion of climbing the mountains, gives full play to the muscles of their thighs and legs, so that they are generally of a handsome and vigorous make, particularly well adapted for all bodily exercises, and for the wild flings of their own national dance.

An attachment to what is old is characteristic of the mountain peasant. Nothing new has been able to intrude itself into these lofty regions. The national costumes, which are for the most part neat, and in good taste, and much better suited to the peasant than a bad imitation of the dress of the towns, is

here found unchanged. At a time when we are anxiously seeking after popular traditions and stories, and all the other monuments of antiquity, it might be worth while to think of preserving a true representation of every Norwegian costume, before they finally disappear.* We have good reason to expect some contributions to such a purpose, from our distinguished landscape painter Flintoe. We find here, also, names which are memorials of the time of Snorré Sturleson. Thus I found at Fossum near Riukandfall, two sisters of the name Lövei and Thuri, two brothers of the name of Baard and Thoromodon Hardangerfield; Ouen (Odin) is common in many places.

Journeys by water in Bergenstift, are both tedious and expensive. Every person who accompanies you must receive 20s. a mile, beside an acknowledgment for the boat. You can seldom get on with fewer than four rowers; and if you are in haste you must take six. If they row a mile in three hours, you cannot complain; and if the wind and current are against you, it is a chance but you take double the time. If you have a fair wind for a little while, the people sit with the sheets in their hand, to be ready to haul down the sails in an instant; for nothing is more unsteady than the wind in the Bergenfiords. In the turning of a hand, it flits round to all the points in the compass, as it beats on different corners of the lofty precipices. The eye has nothing cheerful to dwell upon. Scarcely a blade of grass or a twig, is to be seen on the black mountain walls. The best thing one can do to pass the time, is to lie down and sleep; and the boatmen generally make preparation to accommodate you in this respect, by forming, in the back end of the boat, a kind of couch, of leaves and small twigs. One of my rowers held me awake by his satirical remarks. His sarcasms ran so near the boundaries between joke and earnest, that I did not know very well how to take them, and at last began to get a little sulky; I believe, however, without good reason. In the humorous and comic in an unknown language, and the language of the peasant may be considered as such to an inhabitant of the town, there is often a great deal connected with local circumstances, with which we must be familiar before we can enter into it.

About half past ten in the evening the boat lay to, by the side of the garden of the clergyman in Ullensvang. As it was

so late in the evening I first went up to the house to make inquiries, when I learned that Dean Nils Herzberg had already gone to bed. As I was not sufficiently accustomed to the practice very common in Norway, of converting, if not palaces, at least private houses, into Caravanseras, a liberty which the shocking state of the inns frequently obliges the traveller to take, and as I knew that it was not fair to disturb a clergyman on Saturday,—in short as I did not consider it as very seemly to pay my introductory visit to a stranger after he was in bed and in his first sleep, I resolved to lodge with a peasant close by the parsonage. This peasant was a tenant of the clergyman, and from him I received the unpleasant information, that the Dean was to set off early next morning to perform Divine Service at Kinzervig, and from thence, without stopping, to go on to his brother Dean Christian Herzberg's in Findaas, on Bommel island, there to assist at the Bishop's visitation. This piece of news was a thunderbolt in my ears; I stood so much in need of a day's rest and recreation; and the hope of this, together with that of making the acquaintance of a very worthy man, and a man of science, was at once frustrated. I had tasted nothing the whole day but a piece of rusty smoked herring, which I got at a place where we rested by the way, and which, together with the motion of the waves, occasioned me some unpleasant sensation. When I entered the peasant's house, he himself was sitting on a chair in the middle of the floor of the large smoking room; while his wife, as it was Saturday evening, was occupied in the very necessary task, as it appeared, of combing and cleaning his long hair, hanging down over his eyes and ears. This operation still more increased the irregular motions of my stomach. At last he said to her, "That is enough;" on which the wife went to set before me milk, and bread and butter. Although my body trembled from exhaustion, it was scarcely possible for me to taste a bit. I got a clean bed, however, and early in the morning was awakened out of a sound sleep by a man in a white night-cap and slippers, with a tobacco-pipe in his hand, who stood in the middle of the floor, scolding with all his might, and turning his night-cap from one ear to the other. On coming to myself, after a little consideration, I perceived it was Dean Herzberg, who, in most hospitable terms, was

upbraiding me for not having wakened him the evening before. From this moment all the difficulties of my journey ceased, and as the part of the country which I afterwards went through is better known, my remaining adventures shall be very shortly told.

The Dean had the goodness to put off his journey to Findaas, till mid-day of the 9th of July, that I might make my observations at leisure. This whole neighbourhood is, in a singular degree, remarkable, both from the natural appearance of the place, and from the monuments of former times. Sörfiord or southfiord, on the eastern side of which Ullenswang lies, is here very narrow, about 3500 ells, or one-fifth of a Norwegian mile in breadth. The mountain on the western side, which is apparently above 4000, or, according to Dean Herzberg, above 5000 feet high, rises almost perpendicularly over the sea. Upon its upper surface, lies the extensive glacier of Folgefond, five miles (above 35 English) in length from north to south, and from 1 to 2 in breadth from east to west. It is said, that, under this glacier, has been buried a whole district, called the parish of Folgedal, in which both priests and people were very wicked; and that, in consequence of this, there fell such a quantity of snow, that the great valley they inhabited was filled up with it, to the very top of the mountain. This circumstance is mentioned by Pontoppidan, in his Natural History of Norway. As a confirmation that the district has been inhabited, although the late Professor Smith, not without reason, considers it as improbable either on historical or physical grounds, it is affirmed that the streams which flow from the glacier often bring with them pieces of hand-mills, pieces of timber cut with the axe, old casks, tubs, and other household articles. If I am not mistaken I have read similar stories of other glaciers. That this one is increasing yearly in height, seems probable from the following circumstance: An aged peasant, still alive, told Dean Herzberg, that, either in his own or his father's youth, one could just see the upper line of the glacier over the mountains which lay before his house; whereas now a very considerable portion of it is seen. That such a monstrous mass of ice should increase after it has once been formed, I can readily conceive; but how it should have been first formed on a mountain, the height of which is considerably less than that of the summit of Hardan-

gerfield, where no such masses of solid ice are to be found, is a thing more difficult to be accounted for. Our assumptions with regard to the line of snow, become, in this manner, less certain. May not the different specific component parts of mountains, give them a different capacity for retaining heat? Methinks I have somewhere read a remark, that hills containing metals are unfavourable to vegetation, insomuch that woods seldom thrive on them. The electro-chemical operation which such a combination must of necessity produce, may probably decompose the vapours dissolved in the atmosphere, and thus promote the crystallization of snow and ice. I believe Dean Herzberg has attempted an explanation of this difficulty; and it is to be wished that he would publish his opinion on the subject. None can better judge of an object than those who have it daily before their eyes, and the matter seems to me worthy of investigation.

On the west side of the Fiord, south-west from the parsonage house, lies the old house of Aga. The buildings about this seat are of uncommon size and age, and constructed in a very singular manner. One chamber in particular is very remarkable. One beam is thicker than two of the largest of such as we have at present. The doors are as large as church doors. There are neatly built cellars below; there is a burying vault and a beautiful fruit garden. In short, this house is distinguished in all respects from all other timber buildings; and is supposed to have been erected in the time of Magnus the Crowned, (Magnus Erlingsen?) At this seat also, lived several of the illustrious men of Hardanger, such as Bryniolfr Johnsen, who is supposed to have been the same person who is so often mentioned in the history of Hacon the old; his son Provost Eric Bryniolf, who was alive in King Eric the priest-hater's time in 1298, and who is said to have been drowned by the headland near Hesthammer, in commemoration of which accident, a stone-cross was set up, which is said to be still standing there. The last lies buried in Ullensvang Church, at least there is to be seen there a gravestone of white marble, with this inscription; Here lies Sygurth Bryniolf's son at Aga. Here also lived Thormodaga, a man who has much benefited the parish of Kintseroig, since he was the first who introduced into it apple-trees, by planting a kind of apple, which is still called Thormod's apple. The first

tree he planted, and which Dean Gerard Milzoo says was 100 years old in his time, is still standing at Aga, and notwithstanding its age, which must exceed 350 years, it still surpasses in fruitfulness any of its descendants. This Thormod, therefore, who must have lived in the time of Frederick II. is deservedly remembered with gratitude in Hardanger. The present possessor of this place is the very respectable peasant Joanne Aga, who was a member of Storthing in 1818, and who, both among his fellow representatives, and among all the people of Christiania who knew him, acquired the most honourable estimation.

Close by the clergyman's grounds lies the farm of Oppedal, the largest and the highest rated in the tax-books in all Hardanger. On this there was formerly a church, before that of Ullensvang was built. In the garden belonging to the house, are still found remains of the church-yard. There was also a convent, of which the cellars are still to be seen. North-west from Oppedal on the sea-side, there is the very old house of Helland. The ground was the property of two sisters of high rank and very rich, who it is said had a private passage under ground from the house of the one to the other, of which there are yet some traces. Both Oppedal and Helland, are remarkable for beautiful orchards, where the finest fruit-trees are produced, especially of that kind which is called the Helland apple, and which has long been in great request in Bergen.

Ullensoang Church, and the parsonage-house, from their situation with regard to the mountains, are exposed to the most violent storms. About twelve years ago, if I remember right, such a storm completely overthrew a wing of the latter, in such a manner, that it was with difficulty the Dean and his family escaped from the ruins with their lives. A large barn has been several times beaten down, and it is only by a new construction, and by the propping of immense beams, that it is now put in condition to resist the force of the storm. This barn, like all the other buildings in Hardanger, is covered above with large thin flags, some of which are two or three ells square. The railing round the parsonage garden has been so often blown down by the storm, though every time the Dean put it up again stronger and better than before, that he has been at last obliged to change his plan. He has set it with one foot loose on the ground; ac-

cording as the violence of the storm increases, this goes with an angular motion inwards, stopping when it has formed such an angle with the wind that the oblique force of this is no longer able to overcome its resistance. The sharpness of the angle thus forms a measure of the strength of the storm. When this begins, every door and window-shutter must be made fast, and their pressure on the house is sometimes such, that the beams in the wall slide on one another. Luckily the storm has never such force but in one direction, so that they are the better able to anticipate its effects, and to take the proper measures to resist it.

As I wished to see as much as possible of Bergen Stift, I accepted with pleasure Dean Herzberg's invitation to accompany him to Findaas. We rowed from Ullensvang, about three in the afternoon, dined at Helland with the family of Sheriff Thoren, (he himself was from home); and after this continued our journey during the whole night. From Sorfiord you gradually turn round to the west, when you are a little north from Kinseroig, into Utnes-fiord, and at Utnes, near Hesthammer, you turn south-west into Tamlen-fiord. This is divided by the little island Quarnsoe, into outer and inner Samlen-fiord. Directly over from this island, there lies on the continent a point called Hattesturt, memorable from this circumstance, that in former days the people of Hardanger, before they had churches of their own, brought, as the tradition goes, all their dead bodies to this place, and put them in a hole till they had collected so many as they could carry in a large vessel to Findaas, or Skudesnæs, where they already had churches and church-yards; and as they were wont in this hole to drink their Christmas ale before they set out with the dead bodies, the spot is still called Julestue (Christmas Chamber).

A little farther south, towards the south-east, in a little bay amidst naked mountains, you have a slight glimpse of the manor-house of the barony of Rosendal. Surrounded on three sides by these naked mountains, on the east by Folgeford, on the west concealed by three islands, one cannot imagine a more appropriate retreat for a Danish Nobleman, who, disgusted by the Revolution of 1660, came here to pass the remainder of [his] days in solitude, where the bitterness of his soul, which he [cou]ld here indulge without restraint, so well accorded with the [glo]omy aspect of the objects which daily surrounded him. At

this time, when the whole Danish Nobility were considered as having lost their liberty by the establishment of absolute power, Ludovic Rosenkrantz removed from Denmark to this place, where he occupied the noble residence of Hatteberg, so called before the erection of the Barony. On a white stone over the gate is the following inscription, "*Melius est mori in libertate quam in servitute vivere,*" as if he considered living in this desert as a sort of death.

About eleven o'clock in the evening we arrived at Kaarievgen, on the south end of Stord Island. This place is the residence of Sheriff Budz. The situation of this place is singularly beautiful. At dinner-time arrived his high reverence Bishop Pavel, and, in company with him and several other official men, I set out about six in the evening to Findaas. Bömmelen consists of two peninsulas, connected only by a small tongue, on which stands the parsonage-house of Findaas. On the northern peninsula stands the church of Bremnæs; on the southern that of Bömmelen; but the head church stands on Mostur Island. This island is separated from Bommelen by a strait so small that only a little boat can row through it. At low-water the passengers must come out of the boat, which is then laid on its side, and thus drawn through the strait. Tradition says, that this strait was formerly not so narrow, but that an ogress, who lived on Mostur Island, and who wished to join this to Bömmel Island, went over to the latter island for this purpose; and, setting herself under the steep mountain precipice, tied her garter to a mountain on the opposite island, setting her foot then against a large stone she pulled this band with all her might, and Mostur Island began to move slowly towards her. At the moment, however, when the islands were about to meet the garter broke, on which her back, head, and right arm, struck the precipice behind her with great force. The impression they made is still to be seen on the rock, which exhibits the resemblance of a gigantic female figure, with her arm stretched out. It was lucky for the clergyman at Findaas that the garter broke just in proper time, as he would otherwise have had to make a circuit of about half a mile every Sunday round Mostur Island to get to church.

On Sunday (15th July), a visitation was held in the head church in Mostur Island. This church stands on the east side of the island, close by the harbour of Mostur, where a respectable inn

has been set up. The church is said to be the same which was built by King Oluf Tryggessen, when he landed on the island in 997. If this be true it is the oldest church in Norway. It is of stone, very small, and rudely built, and bears the marks of at least considerable antiquity. On Mostur Island is a fine quarry of marble, which was set agoing by the late Dean Peder Harbœ Herzberg, clergyman of Findaas, and father to the present Herzbergs. He erected on the parsonage grounds a sawing and polishing machine, which was driven by water, where table slabs, steps of stairs, and gravestones, were sawed, hewn and polished, and marble mortars formed. Tradition informs us, that when Oluf Tryggesen saw the new built church, he was so displeased with its shabby appearance, and pitiful size, that, to shew his contempt for it to the architect, he sprung up on the roof just over the door. In springing down again he set his broad feet somewhat hard on the flat stone which lay below, the impression of which is still seen in the mark of two footsteps.

In the church-yard, too, is a pyramidal monumental stone, with a hole as right through the middle as the eye of a needle, which bears witness to his vigour. Coming one day to church on horseback, he looked about without being able to find any thing to which he could tie his horse. On this he went to this stone, and giving it a kick with his heel, a round piece sprung out of it. Through this hole he drew his bridle, and thus relieved himself from his dilemma.

At mid-day on the 17th July I left this delightful party. In one of my boatmen I discovered an old acquaintance and companion in misfortune in the war period of 1814. Every body knows, that at that time the coasts of Norway were closely blockaded by English and Swedish cruisers, and that all intercourse between Norway and Denmark was cut off. In Denmark it was so by a proclamation, of the 28th May the year before, which prohibited, under pain of death, every Norwegian from going to Norway by any other way than through Sweden. But it was impossible, through it, to pass on any other condition than that of taking an oath of allegiance to the King of Sweden; which, under existing circumstances, was a more insurmountable obstacle to such a journey, than the denunciation of the punishment of death or hostile cruisers. Every person who found it necessary to repair to Norway, which happened to be the case with me, as

I had the year before been appointed Lecturer in the Norwegian University, had no alternative but to steal out on various pretexts in a little boat, and leave it to Providence to determine whether he should be swallowed up by the waves, or be taken by the enemy, or succeed in his enterprise. There were at that time several hundred Norwegian sailors in Copenhagen, who had just returned from a six years captivity in England, and who eagerly longed to get back to their native land. I joined myself with twenty of these, purchased the privateer lugger called the Mazarino, sailed with a brisk wind from Copenhagen, on the 14th July, in the forenoon, with my wife, whose birth-day it happened to be, and my youngest brother, and had passed the Scaw Point by nine o'clock in the evening of next day. Our papers bore that we were going to Fladstrand to buy fish; but the owners' letter enjoined us, if there should not be a good market here, to go to Kingkiöberg on the west coast of Jutland, to try our luck there. By this means we could, if necessary, allow ourselves to be visited even north and west from the Scaw. As there was but little wind we wore along the north-west coast of Jutland till 5 in the afternoon of the 16th, for the remaining and most dangerous part of our voyage could only be undertaken with a favourable wind in the night time. At this time there arose a brisk wind from the north-west, upon which, after a consultation, we set out on our voyage.

Art. IV.—*Observations on the Temperature of the Earth at Paramatta, New South Wales.* By His Excellency Sir Thomas Brisbane, K. C. B. F. R. S. Lond. & Ed., &c.*

In the most elevated ground in the neighbourhood of Paramatta, a cylindrical hole was bored in the earth, about 3½ inches in diameter, and passing through clay and rotten sandstone.

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* This paper contains part of a series of valuable Meteorological and Astronomical observations, which Sir Thomas Brisbane, has communicated to Dr Brewster, to be laid before the Royal Society of Edinburgh, and to be subsequently published in whatever way he may consider as most conducive to the interests of science. The Astronomical observations are given in this Number.

At various depths in the bore, the state of the thermometer was observed during the months of November and December 1822, which correspond to May and June of your climate. On some occasions water stood to a certain height in the bore, so that the temperature of the water was measured by the thermometer. The various results are given in Table I.

TABLE I.

	Depth of the Bore 24 feet. Temp. in Air.	Depth of the Bore 24 feet. Temp. in Water.	Depth of Therm. in Bore.	Temp. at the Surface in the Shade.
1822.			Feet.	
Nov. 11,	63°	°	20	84°
		63	24	84
12,	60		12	81
		63	23	84
13,		63	24	79
	60		12	79
	60.2		12	72
		63	24	72
14,	60.2		12	68
18,		63	24	66
	60		12	66
Dec. 2,	60		12	70
	62.5		20	70
3,		63.2	24	66
	60		12	66
19,		62.5	24	68
	62		12	69
20,	62		12	75
		62.5	20	75
21,		62.5	23	70
	62		12	70
24,	67		6	77
	63		9	77
	61		12	77
26,	61.5		15	79
	62		18	79
	63		22	79
27,	66.5		6	80
		63	24	80
Mean,	61.9	62.9		

The mean of all the temperatures, at depths varying from 6 to 24 feet, was 61°.9 in the air, and 62°.9 in the water. This excess of heat in the water no doubt arose from its having descended from the strata nearer the surface.

In another set of experiments made in a bore 12 feet deep, the mean temperature was 60°.4 in the air, and the *very same* in water, as shewn in Table II.

TABLE II.

	Depth of the Bore 12 feet.		Depth of Therm. in Bore.	Temp. of Air at the Surface.
	Temp. in Air.	Temp in Water.		
1822.	°	°	Feet.	°
Nov. 11,	68		11	84
		60	12	84
12,	60		11	81
		60	12	81
13,	60.5		11	79
		60	12	79
		60.2	12	72
	60		10	72
14,		60.2	12	68
Dec. 2,	60		10	64
		60	12	64
19,	60.5		10	69
20,	61		10	75
		61,5	12	75
21,	61		10	68
		61.5	12	68
Mean,	60.4	60,4		

In a third series of observations on the temperature of wells and springs, made in the same months, the mean temperature of a pump-well, 20 feet deep, was 61°.0, and that of a spring at the surface 61°.5, as shewn in Table III.

TABLE III.

	Temp. of Water in the Pump. Depth 20 Feet.	Spring at the Surface.	Temp. of Air at the Surface.
1822,			
Nov. 14,	61.8°	61.5°	68°
15,	61	62	66
16,	60.4	60,2	56
17,	60.2		80
Dec, 19,	61.5	61	69
20,	61	61.8	75
Mean,	61.0	61,3	

The mean of all these results for the mean temperature of the earth at Paramatta in November and December, and probably for the whole year, is 61°.5, whereas the mean temperature of the atmosphere, as calculated by Dr Brewster's formula, is about 63°. This difference of $1\frac{1}{2}$° is nearly the same that exists between the temperature of the earth, and the temperature of the atmosphere in corresponding latitudes in the northern hemisphere.

ART. IV.—*Description of a New Power, and Apparatus for impregnating Mineral Waters with Carbonic Acid.* By Mr CHARLES CAMERON, Chemist, Glasgow. Communicated by the Author, in a Letter to Dr BREWSTER.

THE vessel A, Plate VII. Fig. 6., containing about 15 gallons, is formed of cast-iron, $\frac{5}{8}$ths of an inch thick, and lined with sheet-lead of from 8 to 10 lb. per square foot, having an agitator B covered with lead, working on the pivot below and through the stuffing-box C. By the opening at D, the vessel is filled up to the dotted line with a mixture of whitening and water. The vessel E, containing 2 gallons, is formed of lead, $\frac{5}{8}$ths of an inch thick, and is filled with sulphuric acid up to the dotted line. The acid is kept from falling down into A by the lead-plug F, which is conically pointed, and fits into a corresponding conical opening in the lead-pipe G The plug moves straight up and down through the stuffing-Box H, and is prevented from turning round by the pin K, which moves in a slit in the bridle L, the screw-nut M being rivetted loose into the top of the bridle. By this means the conical point of the plug is preserved from injury, as it is merely lifted out of the opening, and again pushed into it. This is more complicated than a common formed glass or lead stop-cock, but neither of them will answer where a high pressure is applied. The pipe N, inserted into the top of the vessel E, and into the pipe S (which incloses the plug), preserves the equilibrium of pressure, so that the sulphuric acid rises no higher in the pipe S than in E, and consequently preserves the brass-work of the stuffing-box. The intermediate vessel O, containing 3 gallons, is formed of thick lead, or cast-iron lined with lead, and filled with water up to the dotted line; it is employed for retaining any of the sulphuric acid in case it should be carried over by too strong an efferves-

cence. The vessel V, containing 16 gallons, may be formed either of copper tinned, with an agitator of the same metal, or of cast-iron lined with 6 or 8 lb. of lead, and an agitator of maple-wood, which gives no taste to the water. It is filled to the dotted line with water, and a proportional quantity of carbonate of soda, magnesia, or other substance, to be impregnated. F is a pressure-gauge, containing mercury; in the figure it is placed on the top of the vessel, but it is more convenient to place it at a little distance, forming a communication by a pipe. The communicating pipes are lead, and their several uses are distinctly evident in the figure. When the vessels are filled, the mode of operation is extremely simple. On turning the nut M, the sulphuric acid is allowed to come into contact with the whitening; carbonic acid is necessarily disengaged, and in quantity and rapidity proportional to the quantity of sulphuric acid let down.

If the vessels were sufficiently capacious, 10,000 gallons of carbonic acid could be instantaneously produced. But by the alternate turning of the nut M, the sulphuric acid is allowed to fall down in small portions, which regulates the disengagement of the gas, and prevents too great an effervescence. As the gas is still accumulating, having no way to escape, it passes over into the vessel V, and is there absorbed by the water. In this way a pressure from 20 to 30 atmospheres may be thrown into the vessels. It must therefore be obvious to every man of science, that if the vessel A were connected by a pipe, with the valves of an engine somewhat similar to a steam-engine, the vast pressure, which can be so instantaneously produced, would raise and depress alternately the piston of a cylinder: That cylinder, too, would only require to be $\frac{1}{20}$th the diameter of the steam-cylinder to have an equivalent power; and the gas would be reduced to one atmosphere by its alternate escape at the opposite valves, no water being required for condensation. But, unfortunately, the expence of sulphuric acid, from the quantity required (when the gas is allowed to escape), presents an unsurmountable obstacle as a substitute for the steam-engine. Since I discovered the power, from the production of carbonic acid, and put it into practice four years ago, an account of which was noticed in most of the journals and newspapers of the day, I am happy to observe, that that distinguished ornament of our

age, Sir Humphry Davy, has turned his attention to it, and discovered that the gases, at a high pressure, are powerfully acted upon by slight increments of temperature, and the pressure astonishingly augmented.

This circumstance affords us flattering hopes that an engine, constructed on the principles of the Reverend Mr Stirling's air-engine, may yet be made to equal, and in many cases to supersede, the steam-engine, by reducing the expenditure of sulphuric acid. As I have had numerous letters from various parts of the kingdom, requesting a description of the soda-water-apparatus, your giving this a place in your valuable Journal, will, I trust, be a sufficient answer to them, and will confer a very high favour on the author.

GLASGOW, December 10. 1823. — CHARLES CAMERON.

ART. V.—*On Rock Formations.* By Baron ALEXANDER HUMBOLDT. (Concluded from p. 53.)

FROM that scepticism which would deny the existence of any kind of regular order in the position of rocks, it is proper to distinguish an opinion which has sometimes found supporters among experienced observers. According to this opinion, the formations of gneiss-granite, of greywacke, of alpine limestone, and of chalk, which have a uniform superposition in different countries, do not very well correspond among themselves as to the age of the homonymous elements of each series. It is thought that a secondary rock may have been formed on one spot of the globe, while transition rocks did not yet exist on another spot. In this supposition, no allusion is had to those granitic rocks which are found lying above limestone containing orthoceratites, and which are consequently newer than the primitive rocks. It is a fact generally admitted at this day, that formations of *analogous composition* have been repeatedly deposited at epochs far removed from each other. The doubt which we are now considering, (though we do not partake in it), bears on a point much less clearly established,—the ascertaining whether certain mica-slate rocks evidently situate in the midst of a country of primi-

tive rocks, and placed below those in which the vestiges of organic life begin to appear, are newer than the secondary rocks of another country. I confess, that, in the part of the globe which I have had an opportunity of examining, I have not seen any thing that might tend to confirm this opinion. Granular syenitic rocks repeated twice, perhaps even three times, in primitive, intermediary (and secondary) deposits, are analogous phenomena with which we have become acquainted within these fifteen years. The disagreement in regard to age of great homonymous formations, does not by any means seem to me to be proved as yet by direct observations, made upon the contact of superimposed formations. The chalk or Jura limestone may, on one hand, immediately cover primitive granite, and, on the other, be separated from it by numerous secondary and transition rocks: these very common facts demonstrate only the abstraction, the absence, or non-development of several intermediary members of the geognostical series. The greywacke may, on one hand, dip beneath a felspar rock, or rock of which felspar forms a principal constituent; for example, beneath transition granite or zircon syenite; and, on the other hand, be superimposed upon the black limestone containing madrepores; but this position shows only the intercalation of a bed of greywacke between felspar rocks. Since the minute investigation of fossil organic bodies has, through the important labours of Messrs Cuvier and Brongniart, diffused a new life as it were in the study of the tertiary formations, the discovery of the same fossils in analogous beds of very distant countries, has rendered the isochronism of very generally extended formations still more probable.

It is this isochronism alone, this admirable order of succession, which seems given to man to investigate with some degree of certainty. The attempts which theological geologists have made to subject the periods to absolute measurements of time, and to connect the chronology of ancient cosmogonic narrations with the observations of nature, could not possibly have been productive of satisfactory results. "It has been more than once," says M. Ramond, in a discourse replete with philosophical views, "thought that a supplement to our short annals might be found in the monuments of Nature. There is, however, enough of historical ages, to let us see that the succession of physical and mo-

ral events, is not regulated by the uniform progress of time, and could not consequently give it measure. We see behind us a series of creations and destructions, by means of the strata of which the crust of the earth is composed. They give rise to the idea of so many distinct periods; but these periods, so fertile in events, may have been very short, in comparison with the number and importance of the results. Between the creations and destructions, on the other hand, we see nothing, however vast the intervals may be. There, where all is lost in the void of undetermined antiquity, the degrees of relative age have no appreciable value; because the succession of phenomena has no longer the scale which relates to the division of time." (*Mémoires de l'Institut*, for the year 1815, p. 47.)

In the geognostical monography of a deposit of small extent, for example, the environs of a city, one cannot distinguish with sufficient minuteness the different beds which compose the local formations, shelving banks of sand and clay, the subdivisions of gypsums, the strata of marly and oölitic limestone, designated in England by the names of Purbeck Beds, Portland Stone, Coral Rag, Kelloway Rock, and Corn Brash, then acquire a great degree of importance. Thin beds of secondary and tertiary formations, containing assemblages of very characteristic fossil bodies, have furnished, as it were, a *horizon* to the geognost. In their prolongation, whatever occurs placed above or beneath in the order of the whole series, has been referred to one of them. Even the particular denominations by which beds are distinguished, are of much importance in a geognostical description, however whimsical or improper may be their signification or their origin as taken from the language of miners. But while treating of the relative position of rocks on a surface of great extent, it is indispensably necessary to consider the formations or habitual associations of certain beds in a more general point of view. It is then that discretion and circumspection are more necessary in the distinction of rocks, and in their nomenclature. The work of M. Freiesleben on the Plains of Saxony, which are upwards of 700 square leagues in extent (*Geogr. Beschr. des Kupferschiefergebirges*, 1807—15), presents a beautiful model of the union of local observations and geognostical generalizations. These generalizations, these attempts to simplify the system

of formations, and to direct the attention more especially to great characteristic features, should be more or less cautiously conducted, according as one describes the basin of a river, an isolated province, a great country such as France or Germany, or an entire continent.

The more minute the investigation of districts becomes, the more does the connection between formations which appear at first perfectly independent, manifest itself by the great phenomenon of *alternation*; that is to say, by a periodical succession of beds which present a certain analogy in their composition, and sometimes even in certain fossil organic bodies. It is thus that, in the transition-mountains, for example, in America (at the entrance of the plains of Calabozo), beds of greenstone and euphotide, in Saxony (near Friedrichswalde and Meissen) the clay-slates with glance-coal, the greywackes, porphyries, black limestones, and greenstones, constitute, from their frequent and repeated *alternation*, a single formation. It often happens that subordinate beds appear only at the extreme limits of a formation, and assume the aspect of an independent formation. The cupreous and bituminous marls (*Kupferschiefer*), which occur in Thuringia between the alpine limestone (*zechstein*) and the red sandstone (*rothes liegende*), and which have for ages been extensively wrought, are represented in several parts of Mexico, of New Andalusia, and of Southern Bavaria, by multiplied beds of marly clay, more or less carburetted, and included within the alpine limestone. Similar circumstances often give to gypsums, sandstones, and small beds of compact limestones, the appearance of particular formations. Their dependence on *subordination* is known by their frequent association with other rocks, by their want of extent and of thickness, or by their total suppression, which is frequently observed. It must not be forgot (and this fact has struck me much in the two hemispheres) that the great formations of limestones, for example, the alpine limestone, have *their sandstones*, as the very generally extended sandstones have *their limestone beds*. Thin beds of sandstones, of limestones, and of gypsums, characterize, in all the zones, the deposites of coal and rock-salt or muriatiferous clay (*salzthon*), isolated deposites, which are most commonly only covered by these small local formations. It is by overlooking these consi-

derations, which should be familiar to every practical geologist, that the type of the great independent formations has been rendered too complicated.

The phenomenon of *alternation* manifests itself, either locally in rocks, superimposed several times upon each other, and constituting a single compound formation, or in the series of formations considered in their aggregate. It is either greenstones and syenites, slates and transition limestones, beds of limestones and of marl, that alternate immediately, or the whole is a system of mica-slates, and of granular feldspathic rocks (granites, gneisses, and syenites), which reappear among the transition deposits, and which separate from the primitive homonymous system the greywackes and limestones with orthoceratites. For the first knowledge of this fact, one of the most important and least studied of modern geognosy, we are indebted to the beautiful observations of Messrs Leopold von Buch, Brochant, and Haussmann. From the circumstance that, in the transition system, granular rocks, perfectly destitute of organic remains, succeed to compact rocks which contain these same remains, it has been concluded by geognosts of great name, that this alternation of shelly and not-shelly rocks, might extend beyond the deposites which we call primitive. It has not been merely asked if the clay-slates, mica-slates, and gneisses, support the granites which have been considered as the oldest; the question has also been agitated, whether greywackes and black limestones with madrepores might not recur beneath those same granites. According to this idea, the primitive and transition rocks would only form a single deposite; and the first might be regarded as intercalated in a deposite posterior to the development of organic beings, and which might penetrate to an unknown depth into the interior of the globe. I confess, that no direct observation can be as yet adduced in support of these opinions. The fragments of rocks which I have seen contained in the lithoid lavas of the volcanoes of Mexico, Quito, and Vesuvius, and which are thought to have been torn from the bowels of the earth, seem to belong to altered rocks of granite, mica-slate, syenite, and granular limestone, and not to greywackes and limestone with madrepores.

We have preserved in the arrangement of rocks the great divisions known by the name of primitive, transition or inter-

mediary, secondary and tertiary deposites. The natural limits of these four *systems of rocks* are the clay-slate with glance-coal or ampelite and lydian stone, alternating with compact limestones and greywackes, the coal formation, and the formations which immediately succeed the chalk. In geognosy, as in descriptive botany, the subdivisions or small groups of families have more distinct characters than the great divisions or classes. It is the case with all the sciences; in which we rise from individuals to species, from species to genera, and from these to still higher degrees of abstraction. A method necessarily rests upon *differently graduated abstractions*, and the passages become more frequent in proportion as the characters are more complex. The transition or intermediary formations of Werner, which M. de Buch has first limited with the sagacity for which he is distinguished (Moll's Jahrb. 1798, b. ii. p. 254.), are connected by the ampelitic clay-slates, the syenites with zircons, the granite sometimes destitute of hornblende, and the anthracitic mica-slate, with the primitive deposite; while the small-grained greywackes and madreporous and compact limestones, connect them with the coal sandstones and limestones of the secondary deposites.

Porphyries of very different formations have their principal seat among the transition rocks; but they break out, if we may so speak, in considerable masses towards the secondary deposites, where they are connected with the coal sandstone, while they penetrate into the primitive class only as subordinate rocks, and of little thickness. The progressive motion, or, if I may be allowed to use the expression, the extent of the *oscillation* of the serpentine and euphotide, is very different. Those diallage rocks, constituting many distinct formations, rarely covered with other rocks, stop short nearly at the lower boundary of the secondary formations; towards the bottom they penetrate into the primitive deposites to beyond the mica-schist. The chalk seems to present a natural limit to the tertiary formations, which were first characterised by Messrs Cuvier and Brongniart, and justly, as deposites entirely different from the last secondary formations, described by the Freyberg School (*Géogr. Miner. des Environs des Paris*, p. 8. and 9.) Struck with the relations which exist between the tertiary deposites and

the beds beneath the chalk, M. Brongniart has even recently proposed to designate the tertiary formations by the name of *upper secondary* deposites, (*Sur le gisement des Ophiolithes*, p. 37). Compare also the very interesting geognostical discussions contained in *M. de Bonnard's Traité des Roches*, p. 188, 210, and 212.)

The distinction of four deposites which we have successively named, and of which three are posterior to the development of organic life upon the globe, appears to me worthy of being retained, notwithstanding the passage of some formations to others of a very different character, and notwithstanding the doubts which several very distinguished geognosts have founded upon these passages. The classification of deposites marks great epochs of nature; for example, the first appearance of some pelagic animals (zoophytes, cephalopodous mollusca), and the simultaneous destruction of an enormous mass of monocotyledons. It presents as it were points of rest to the mind, and by keeping in view that the formations themselves are much less important than the great divisions, we have often an opportunity, on advancing from high mountains toward the plains, of observing the varied influence which the association of primitive and transition rocks, and that of secondrry and tertiary ones, have exercised upon the inequality and configuration of the ground. It is owing to this influence, that the aspect of the landscape, the form of mountains and platforms, and the character of the vegetation, vary less, when we travel parallel to the direction of the beds, than on cutting them at a right angle. (Greenough, Crit. Exam. of Geology, p. 38.)

I continue, by following Messrs de Buch, Freiesleben, Brochant, Beudant, Buckland, Raumer (*Geb.* von Nieder-Schles., 1819), and other celebrated geognosts, to group the independent formations according to the divisions, into primitive, transition, secondary, and tertiary deposites, without troubling myself about the impropriety of the greater number of these denominations. I continue to separate the clay (with lignites) superimposed upon the chalk, from that which is beneath it, and the chalk itself from the more ancient secondary formations. But these distinctions, by beds and groups of beds, so useful in the description of a deposite of small extent, ought not to prevent

the geognost, when he tries to rise to a more general point of view, from connecting these clays and the chalk with the Jura limestone, and from regarding them as the last strata of this great formation, composed of calcareous and marly beds. The inferior beds of the chalk (tuffeau) contain ammonites. The limestone of the mountain of St Peter of Maestricht indicates, as has already been observed by Messrs Omalius and Brongniart (Geogr. Miner., p. 13), the passage of the chalk to older secondary limestones. Near Caen, according to the beautiful observations of M. Prevost, the clays beneath the chalk contain those same lignites which occur, in greater quantity, in the clay which is situated immediately above the chalk: cerites, which bring to mind the coarse limestone of Paris, are seen in a limestone with trigonias, placed between clays inferior to the chalk and the oolitic beds. I do not insist upon these particular facts; I mention them only to prove, by a striking example, how, on bringing together facts observed in different points of the same country, the great phenomenon of *alternation* reveals to us the connections between formations which at first sight appear to have nothing in common. It is the property of those beds which alternate with one another, of those rocks which succeed each other in *periodical series*, to present the most marked contrast in the two beds which immediately follow each other. In geognosy, as in the different parts of descriptive natural history, the advantage of classifications of variously graduated sections must be recognised, without losing sight of the unity of nature; and those who have contributed the most to the advancement of natural philosophy, have possessed at once both the tendency to generalize, and the exact knowledge of a mass of particular facts.

It has been customary to terminate the series of deposites by the volcanic rocks, and to make them succeed the secondary and tertiary, and even the alluvial deposites. In a system constructed upon the principle of relative antiquity, this arrangement seems to me to have little to recommend it. It is without doubt the case that lithoid lavas are spread over the most recent formations, even over beds of gravel; nor can it be denied that there exist volcanic productions of different epochs: but, from what I have observed in the Cordilleras of Peru, of Quito, and of

Mexico, in a part of the world so celebrated for the frequency of volcanoes, it seems to me, that the chief site of subterranean fires is in the transition rocks, and beneath those rocks. I have observed, that all the burning or extinct craters of the Andes open in the midst of trap porphyries or trachytes, (Berl. Abhandl. der Kön. Acad., 1813, p. 131), and that these trachytes are connected with the great transition *porphyry*, and *syenite formation*. According to this observation, it appears more natural to me to make the secondary and volcanic deposites to follow the transition deposite in a parallel manner, and as by bisection. By this new arrangement, the formation of porphyries, syenites and greywackes, or that of transition porphyries, syenites and granites, occurs connected at the same time; 1*st*, With the porphyries of the red sandstone in the secondary coal-deposite; 2*dly*, With the trachytes or trap porphyries which are destitute of quartz, and mixed with pyroxene. I employ with regret the term *volcanic terrain*, not that I doubt, like those who designate the trachytes, basalts and phonolites (porphyrschiefer), by the name of *trap terrain*, that all which I have associated in the volcanic terrain has not been produced or altered by fire; but because several rocks, intercalated between the (primitive?) transition and secondary rocks, might also be volcanic. I would rather wish to avoid every (historical) idea of the origin of things, in a (statistical) view of relative situation or superposition. At Skeen, in Norway, a basaltic and porous syenite, containing pyroxenes, is placed, according to the observation of M. de Buch, between the transition limestone and the syenite with zircons. It is a bed, not a dike; and this is a much less problematical phenomenon than the basalt (Urgrünstein, Buch. *Geogn. Beob.* p. 124, and Raumer, *Granit des Riesengebirges*, p. 70.) contained in the mica-schist of Krobsdorf in Silesia. The trachytes, with obsidian of Mexico, are intimately connected with the transition porphyries which alternate with syenites. The amygdaloid belonging to the red sandstone, assumes, on the Continent of Europe, and in Equinoctial America, all the appearance of an amygdaloid of the basaltic formation. M. Boué, in his interesting *Essai Geologique sur l'Ecosse*, p. 126, 162, has described pyroxenic rocks (dolerites) included in the red sandstone. Without prejudging any thing regarding the origin of these masses,

or in general regarding that of all the primitive and transition rocks, we designate here, by the name of Volcanic Terrains, *the least interrupted series* of rocks altered by fire.

In drawing up the enumeration of the different rocks, I have made use of the names most generally employed by the geognosts of France, Germany, England, and Italy: in attempting to perfect the nomenclature of formations, I should be apprehensive of adding new difficulties to those which the discussion of relative positions already present. I have, however, carefully avoided the denominations, too long preserved, of *under* and *upper limestone;* of gypsum of the *first, second, or third formation,* of *old* and *new red sandstone,* &c. These denominations without doubt present a true geognostical character; they have relation, not to the composition of rocks, but to their relative age. However, as the general type of the formations of Europe cannot be modelled after that of a single district, the necessity of admitting parallel formations *(sich vertretende Gebirgsarten)*, renders the names of *first* or *second* gypsum, of *old* or *middle* sandstone, extremely vague and obscure. In one country it is proper to consider a bed of gypsum or of common sandstone as a particular formation; while in another, it should be regarded as subordinate to neighbouring formations. The *geographical denominations* are without doubt the best; they give rise to precise ideas of superposition. When it is said that a formation is identical with the porphyry of Christiania, the lias of Dorsetshire, the sandstone of Nebra (bunter sandstein), the coarse limestone of Paris, these assertions leave no doubt in the mind of an experienced geognost, regarding the position which is to be assigned to the formation in question. It is also by silent convention, as it were, that the words *zechstein of Thuringia, Derbyshire Limestone, Paris Formation,* &c. have been introduced into mineralogical language. They express a limestone which immediately succeeds the red sandstone of the coal deposite, a transition limestone placed beneath the coal sandstone, and lastly formations of more recent origin than the chalk. The only difficulties which the multiplicity of these geographical denominations presents, consist in the choice of names, and in the degree of certainty which may have been acquired, regarding the position or relative age of the rock to which the others

are referred. The English geognosts look upon the continent for their *lias* and *red marl*; the German for their *bunte sandstein* and *muschelkalk*. These words present themselves in the minds of travellers associated with remembrances of localities. It is not of so much importance, therefore, to produce precise ideas, as to make choice of localities generally known, and which are celebrated, either by the working of mines, or by descriptive works.

In order to diminish the effects of national vanity, and to attach new names to more important objects, I proposed a long time ago, (1795), the denominations of *Alpine Limestone*, and *Jura Limestone*. A portion of the High Alps of Switzerland, and the greater part of Jura, are without doubt formed of these two rocks: the names, however, generally received at the present day, of Alpine Limestone (Zechstein), and Jura Limestone, should in my opinion be modified or entirely abandoned. The lower beds of the Jura mountains, filled with gryphites, belong to an older formation, perhaps to the zechstein; and a great part of the limestone of the Alps of Switzerland assuredly is not zechstein; but, according to Messrs de Buch and Escher, transition limestone. It would therefore be better to choose the geographical names of rocks from among the names of isolated mountains, the whole visible mass of which belongs only to a single formation, than to derive them, as I have erroneously done, from entire chains. I have thought, and many geognosts have formed the same opinion, that the Jura limestone (cavernous limestone of Franconia) was generally placed upon the continent, beneath the Nebra sandstone, (bunte sandstein), between this sandstone and the zechstein. Subsequent observations have proved, that the name of Jura Limestone had with reason been applied to rocks which are very distant from the mountains of Western Switzerland; but that the true geognostical place of this formation, (when there is not a *suppression* of the inferior formations), occurs above the Nebra sandstone, between the shell-limestone (muschelkalk, or the quadersandstein), and the chalk. A geographical name, justly applied to several analogous rocks, renders us attentive to their identity of relative position; but the place which homonymous rocks ought to occupy in the total series, is not well determined except when the

geographical name has been selected, after having acquired a perfect certainty regarding their position. Circumstances are the same with regard to the relative age of the molasse of Argovia, (nagelfluhe and of the Pirna quadersandstein (grès blanc of M. de Bonnard), two rocks of very recent origin, which have been very well examined separately, but whose relations to each other, and to the chalk and Jura limestone, have only been illustrated of late. One may therefore be pretty sure of having met in the New Continent with rocks identical with the molasse or quadersandstein, without being able to pronounce with certainty upon their relations with all the secondary or tertiary rocks. When rocks are not immediately in contact, and are not covered by deposites of known position, their relative age can only be conjectured from simple analogies.

The *terms* of the geognostical series are either *simple* or *complex*. To the simple terms belong the greater number of the primitive formations: the granites, gneisses, mica-slates, clay-slates, &c. The complex terms occur in greater numbers among the transition rocks: there, each formation includes an entire group of rocks, which alternate periodically. The terms of the series are not transition limestones or greywackes, constituting independent formations; they are associations of clay-slate, greenstone, and greywacke; of porphyry and greywacke; of granular steatitic limestone, and of conglomerates, composed of primitive rocks; of clay-slate and black limestone. When these associations are formed of three or four rocks which alternate, it is difficult to give them significant names,—names indicative of the whole composition of the group,—of all the partial members of the complex term of the series. It may then assist in fixing the groups in the memory, to retrace the rocks which predominate in them, without being absolutely wanting in the neighbouring groups. It is in this manner that the granular steatitic limestone characterises the Tarantaise formation; the greywacke, the great transition formation of the Hartz and of the banks of the Rhine; the metalliferous porphyries rich in hornblende, and almost destitute of quartz, the formation of Mexico and of Hungary. If these phenomena of alternation attain their *maximum* in the transition districts, still they are not entirely excluded from the primitive and secondary terrain. In

both of these terrains, complex terms are mixed with the simple terms of the geognostical series. I shall mention among the secondary formations, the sandstone placed below the alpine limestone, (the Nebra sandstone, bunte sandstein), which is an association of marly clay, sandstone and oolites; the limestone which covers the red-sandstone of the coal-formation (the zechstein or alpen-kalkstein), which is a less constant association of limestone, of (muriatiferous) gypsum, of stinkstone and of pulverulent bituminous marl. In the primitive class we find the three first terms of the series; the oldest rocks either isolated, or alternating two and two, according as they are geognostically more approximated by their relative age, or the whole three alternating. The granite sometimes forms constant associations with the gneiss, and the gneiss with the mica-slate. These alternations follow particular laws: we see, (for example in Brazil, and, although less distinctly, in the maritime chain of Venezuela), the granite, gneiss and mica-schist in a triple association; but I have not found granite alternating alone with mica-slate, or gneiss and mica-slate alternating by themselves with clay-slate.

We must not confound, and on this point I have often insisted in the present article, rocks passing insensibly to those which are in immediate contact with them; for example, mica-slates, which *oscillate* between gneiss and clay-slate, with rocks which alternate with one another, and which preserve all their distinctive characters of composition and of structure. M. D'Aubuisson has long ago shewn how chemical analysis approximates the clay-slate to mica. (*Journal de Physique*, vol. 68. p. 128.; *Traité de Geognosie*, vol. ii. p. 97.) The first, it is true, has not the metallic lustre of mica-slate; it contains a little less potash, and more carbon; the silex does not unite into nodules or thin laminæ of quartz, as in the mica-slate; but it cannot be doubted, that scales of mica form the principal base of the clay-slate. These scales are so joined together, that the eye cannot distinguish them in the mass. It is perhaps this same affinity which prevents the alternation of clay-slates and mica-slates: for in these alternations Nature seems to favour the association of heterogeneous rocks; or, to make use of a figurative expression, she delights in the associations whose alternating rocks present a great contrast of crystallization, of mixture and

of colour. At Mexico, I have seen dark greenstones, alternate thousands of times with reddish-white syenites, abounding more in quartz than in felspar. In this greenstone there were veins of syenite, and in the syenite veins of greenstone; but none of the two rocks passed into the other. *(Essai politique sur la Nouvelle Espagne*, v. ii. p. 523.) They present at the limit of their mutual contact, differences as marked as the porphyries which alternate with the greywackes or with the syenites, as the black limestones which alternate with the transition clay-slates, and so many other rocks of entirely heterogeneous composition and aspect. Further, when, in primitive deposites, rocks more related by the nature of their composition than by their structure or mode of aggregation, for example, the granites and gneisses, or the gneisses and mica-schists, alternate; these rocks do not by any means show the same tendency to pass into each other, as they present, when isolated in formations which are not of a complex character. We have already observed, that often a bed β, becoming more frequent in the rock α, announces to the traveller that the simple formation α, is to be succeeded by a compound formation, in which α and β alternate. Farther on, it happens, that β assumes a greater development; that α is no longer an alternating rock, but a simple bed subordinate to β, and that this rock β shows itself alone, until, by the frequent repetition of beds γ, it becomes the precursor of a compound formation of β, alternating with γ. We might substitute for these signs the words granite, gneiss, and mica-slate; those of porphyry, greywacke and syenite; of gypsum, marl and fetid limestone (stinkstein). *Pasigraphic* language has the advantage of generalizing the problems; it is more conformable to the wants of *geognostical philosophy*, of which I attempt to present here the first elements, in so far as they have relation to the study of the superposition of rocks. Now, if often between formations which are simple and very closely allied, in the order of their relative antiquity, between the formations α, β, γ, there occur compound formations interposed, $\alpha\beta$ and $\beta\gamma$, (that is to say α alternating with β, and β alternating with γ); we observe, also, although less frequently, that a formation (for example α,) assumes so extraordinary an increase, that it envelopes the forma-

tion β; and that β, instead of showing itself as an independent rock, placed between α and γ, is now nothing but a bed in α. It is thus, that, in Lower Silesia, the red-sandstone contains the formation of zechstein; for the limestone of Runzendorf, filled with impressions of fishes, and analogous to the bituminous marl abounding in fishes of Thuringia, is entirely developed in the coal-formation. (Buch, *Beob.* vol. i. p. 104. 157.; *Id.* Reisenach Norwegen, vol. i. p. 158.; Raumer, *Gebirge von Nieder-schlesien*, p. 79.) M. Beudant, *Voy. Miner.*, vol. iii. p. 183., has observed a similar phenomenon in Hungary. In other districts, for example, in Switzerland, at the southern extremity of Saxony, the red-sandstone disappears entirely; because it is replaced, and, so to speak, overcome, by a prodigious development of greywacke or of alpine limestone. (Friesleben, Kupfersch. p. 109.) These effects of the alternation or unequal development of rocks, are so much the more worthy of attention, that their study may throw light upon some apparent deviations from a generally acknowledged type of superposition, and that it may serve to refer to a common type the series of position observed in very distant countries.

In order to designate the formations composed of two rocks which alternate with another, I have generally preferred the words *granite and gneiss, syenite and greenstone,* to the more commonly adopted expressions of *granite-gneiss, syenite-greenstone.* I was apprehensive that this last method of designating formations composed of alternating rocks, might rather give rise to the idea of a passage from granite to gneiss, from syenite to greenstone. In fact, a geognost, whose works upon the trachytes of Germany have not been sufficiently appreciated, M. Nose, has already made use of the words *granite-porphyries* and *porphyry-granites*, to indicate varieties of structure and aspect, to separate the porphyritic granites from porphyries, which, from the frequency of crystals imbedded in the mass, presents an aggregational, a true granitic structure. By adopting the denominations of granite and gneiss, of syenite and porphyry, of greywacke and porphyry, of limestone and clay-slate, no doubt is left regarding the nature of the complex terms of the geognostical series *.

* Translated from Essai Geognostique par Baron Alexandre de Humboldt.

M. Humboldt next proceeds to consider the natural history of fossil organic remains, as connected with formations. This very interesting paper on petrifactions, has already appeared in No. xvii. of our Journal.

Art. VI.—*Description of a newly discovered Temple, at Cadachio, in Corfu.* In a Letter to Sir James Maccrigor, Knt. By Samuel Roe, Esq., Surgeon, 78th Regiment.

My Dear Sir James,

Since I had the honour of seeing you, I have not observed any thing which demanded particular notice at this station, which was not more or less professional, and consequently reported to you through my superior officers. But of late, the Ruins of a Temple having been discovered, of very remote date, it has excited the interest of all travellers, and of others, who have visited the spot.

I beg to lay before you the fullest account of the origin, situation, extent, and present state of it, which it is in my power to give in the compass of a letter. In doing this, I am much indebted to Colonel Whitmore, the Commanding Officer of Engineers on this station, under whose orders the excavations have been carried on; and, as they still work at the ruins, I shall acquaint you with any other discoveries which may be made from time to time.

During last autumn, the springs in the island (which usually supply the Navy with water) being unprecedentedly low, the engineers were employed to ascertain how far their ancient sources could be recovered. In this search for the feeders of the fountain, the fluted shaft of a Doric column, rising above the soil, attracted attention. It was found *in situ*, and further excavation exposed the ground-plan of a Temple, situate 63 feet $6\frac{1}{4}$ inches above the fountain, and about 99 feet $6\frac{1}{4}$ inches above the sea.

I shall now endeavour to describe to you the situation of surrounding objects. About two miles from Corfu, in a SE. direction, is the high ridge of Mount Ascension, composed principally of sandstone, and covered thickly with luxuriant olive

trees. To the northward of this mountain, a small bay is formed by the sea, where boats approach the shore, to water at the fountains, supplied by springs, which discharge themselves at the bottom of a natural ravine, between two hills of sandstone, and 36 feet above the sea. In the hottest season, they produce 5480 gallons of water daily. About half way from the summit of Mount Ascension to the sea, were found the buried Ruins of Cadachio, and aqueducts of considerable extent. The edifice was Doric hexastyle, and stood E. SE. and W. NW. The six columns which supported the pediment, on the land side, and seven of the lateral ones, though much decayed, were in their places, but the remainder, and nearly half the cella, had fallen into the sea.

In its original state, the peristyle probably consisted of thirty columns, standing on a stylobate of two steps. The divisions of the cell cannot now be traced, but a remarkable erection still exists within it, and seems to point out the situation of the altar, which was coated with some foreign substances. The intercolumniation is diastyle. The zophoros or frieze is totally wanting; and the corona, which is not Doric, as well as the epistylium or architrave, exhibit no remains of guttæ, regulæ, or mutules.

The abacus is plain, and the echinus flat, like those of the best examples; the flutes, which are twenty in number, pass through the hypotrachelium or neck, which is cut by two grooves. The walls that remain of the cella are but two courses, or about 2 feet 9 inches above their foundation, and the only entrance appears to have been on the sea side.

The general Dimensions of the Building are nearly as follows:

		Ft.	In.	
Breadth of the Cell, - -		24	0	
Do. of the Portico, exclusive of the steps, -		38	4	
Upper diameter of the Columns, - -		1	6	
Lower diameter, - -		2	0	
Height of the Shaft, - -		9	8	
Height of the Capital, -	Abacus, -	0	$5\frac{3}{4}$	
	Echinus, -	0	6	
Clear intercolumniation, - - -		5	6	These however vary.
Intercolumniation of the Angles, - -		5	4	

	Ft.	In.
Height of the Architrave, - - -	1	6
——— of the Cornice, - - -	1	0
Tænia, - - -	0	4¼
Breadth of the Pteroma, or Ambulatory, at the sides,	5	5
Do. on the land front, - - -	7	4
Height of the upper step, - - -	1	1
Do. of the lower step, - - -	1	0
Head of the lower step, - - -	1	0
Height of the centre stone of the Fastigium or Pediment,	5	1

It is observable that all the columns were found erect, while the superstructure had fallen outwards, on different levels, in the earth, that has gradually buried the building, which proves the decay to have been gradual; for, had it been effected by earthquakes or by design, the fragments would have encumbered the original pavement, and the columns, which were not secured to the stylobate, must also have fallen. The Temple was covered with tiles, in the usual manner, and many have been found with names impressed on them, which were probably those of the Chief Magistrates, when the work was commenced or renovated. Amongst them are these:

ΕΠΙ ΑΡΙΣΤΟΜΕΝΗΣ............Under Aristomenes.
ΕΠΙ ΘΕΡΣΙΑ........ ....Under Thersia.
ΕΠΙ ΔΑΜΩΝΟΣ................. Under Damon.
ΕΠΙ ΑΡΙΣΤΕΑ...................Under Aristea.
ΕΠΙ ΦΙλΩΝΙΔΑ...... ....Under Philonidas.

ΕΥΓ.Ο7ΕΜΟΥ

ΕΠΙ ΠΑΙΥΗΕ

— On the cover of an oil jar, ʌ Λ
— On several tiles, (Λ) and Α —

The forms of some of the letters mark a very distant period. Mustoxidi, in his History of Corfu, imagines Aristomenes to have been Chief Magistrate during the Peloponnesian War; but a sure criterion of the antiquity of this Temple may be found in the proportion of its columns,—their diminution,—the grooves in the hypotrachelium,—and, if we may presume the frieze to have been of the usual height, in the altitude of the entablature, which would have been about four modules; and these agree with those of the Parthenon and Temple of The-

seus at Athens; so that Colonel Whitmore says, that we are authorised to fix the date of its erection some time in the fifth century before Christ. About 2 feet distant from the sides of the edifice, two wells have been discovered; they are between 30 and 40 feet in depth, and lead to subterraneous aqueducts. These canals are on an average 6 feet in height, 2 feet 6 inches in breadth, and have been explored by the engineers to the extent of 1400 feet. Their primary object was the preservation of the Temple. Their secondary one, to conduct the springs in Mount Ascension to a more remote point. These aqueducts, and the Temple, are evidently referred to in a marble existing in the Verona Museum. It has been translated by Maffei, from the original Doric dialect, into Latin, and by Mustoxidi from the Latin into Italian. The inscription commemorates the sanction of the Corcyrean Republic for the formation of certain public works.

It details the cost of tin, lead, brass, cartage, excavation, and workmanship; the expence of a brazen serpent, of nitre or nitron, for the altar; the erection of an obelisk, and of a wall built by Metrodorus; the Judges and Magistrates, both within and without the city, approve in it what had been executed; they state the renewal of the roof of the Temple; the abduction of the water courses, lest the force of the springs should injure the retaining-wall, and (although much is defaced and wanting) they intimate, that the impetus of the flowing waters was to be diverted from the Temple towards the docks and storehouses. Maffei further supposes it to enjoin, that the *cippus* of a god, whose initial A only is indicated, should be carefully placed within the Temple, and imagines, that the brazen serpent before mentioned, marks the divinity to have been Æsculapius. Mustoxidi translates this passage literally, as well as the remarks drawn by Maffei from Pliny, relative to the nitre for the altar. But the tablet, unfortunately for the former hypothesis, does not contain a word correspondent with cippus, or an expression intimating the removal of any thing belonging to a God; and, perhaps, the more simple interpretation would have been, that the Judges and Magistrates direct their decree to be inscribed in columns, or in the columnar manner, on the wall of Metrodorus, over against the Temple of the God A.

The columnar manner of writing was adopted in the public decrees of the people, estimates for public works, &c. If this reading is admitted (which Colonel W. does admit), it will do away the difficulties of Maffei's conjecture, that the decree was to be inscribed on a column, and placed on a wall.

It is worthy of being remarked, how precisely the situation of this building accords with the inscription on the Verona Tablet: *First*, There is a Temple placed, contrary to common practice, in a ravine, and subject to the injury of subterranean waters: *Secondly*, A retaining-wall is built, to lessen their bad effects: *Thirdly*, Aqueducts are formed to draw the springs from the foundations, and conduct them, on the highest possible level, for a distant purpose: And, *fourthly*, the Temple contained an altar, for which nitron was purchased. Colonel W. remarks, "The ancients possessed such an imperfect knowledge of nitron or nitre, that natron, another name for soda, is generally presumed to be that which Pliny and his predecessors styled Nitron; and it is very singular, that the altar still exhibits, after the lapse of 22 centuries, fragments of a coating that appears to contain soda, in the earthy matter composing it." This substance which the Colonel speaks of, is chalk.

With respect to the divinity; the letter A, and the brazen serpent, would equally indicate Apollo and Æsculapius; and, in conjecturing on this point, I should prefer (as the Colonel also does) the former, from the consideration of the existence in ancient times of a fountain, which must have been supplied from the same springs, about 700 yards distant from the aqueducts, and was called the Pythean Fount,—ΡΟΟΣΠΥΘΑΙΟΣ.

The excavations of Cadachio have further brought to light several female heads, in terra cota, lachrymatories, brazen pateræ, scarabæi, glass-beads, pottery, ivory, copper, iron, and lead, a brass wheel, heads of arrows, rings; and a multitude of coins, amongst which are some of Epirus, Apollonia, Corinth, Syracuse, and Corcyra. With respect to the articles usually deposited in tombs, but found on the site of the Temple, it appears to Colonel Whitmore, that its position, being in a ravine and water-course, any light substance detached from the neighbouring hills would be carried down by rains, till meeting such obstructions as the walls of the cella or stylobate of the Temple, they

would be buried under fresh deposites, by a continuation of the same agency. If, therefore, it may be presumed, that the sides of the Cadachio ravine have been denuded and precipitous, they would be calculated for the excavations used as places of sepulture by the early Greeks; in which case we should be warranted in concluding, that they might attract the curiosity of the Roman Conqueror, who, already elated by the plunder of Corinthian tombs, would naturally expect from a Corinthian colony the necro-corynthes, or mortuary vases, that found such eager purchasers among their wealthy patricians.

Thus, in pursuit of richer relics, the lesser would be neglected, and, being once dilapidated, become subject to the impulse of the torrents.

An unexpected opportunity of writing to England having occurred, I have been obliged to draw up a hurried description of the ruins, from my irregular notes, and without a plan of the building, which I had intended to submit to you.

With every sentiment of esteem, I remain, most respectfully yours,

CORFU, *May* 13. 1823. SAM. ROE.

ART. VII.—*Astronomical Observations made at Paramatta in* 1823. By his Excellency Sir THOMAS BRISBANE, K. C. B., F. R. S. Lond. & Edin. &c. &c, and Mr RUMKER. Communicated by the Authors.

THE following astronomical observations, communicated in a letter to Dr Brewster from Sir Thomas Brisbane, consist,

1. Of the Eclipse of the Moon of January 26. 1823;
2. Of Occultations of the Fixed Stars;
3. Of Eclipses of Jupiter's Satellites; and,
4. Of a comparison of these Observations with the calculated results, in order to determine the Longitude of the Observatory at Paramatta.

When the results of these observations are compared with corresponding ones made in Europe, a more accurate determination of the position of the Observatory will be obtained; but it is unfortunate that none of the eclipses of Jupiter's satellites that were observed at Paramatta are to be found among the published observations of the same phenomena at the Royal Observatory at Greenwich.

1. *Eclipse of the Moon, January* 26. 1823, *observed at the Observatory in Paramatta.*

Number and Name of the Spot.	Immersion. The Spot immerges into the Shade.	Immersion. Is totally overshaded.	Number and Name of the Spot.	Emersion. The Centre Emerges.
	Mean Time.			Mean Time.
2 Galileo, -	1h 48′ 13″	*	5 Gassendi, -	4h 30′ 35″
4 Kepler, -	1 51 50		4 Kepler, -	4 31 15
3 Aristarchus,	1 53 48	1h 51′ 45″	24 Manilius, -	4 50 35
14 Bullialdus,	1 55 13		25 Menelaus,	4 53 11
10 Reinold, -	1 58 32		28 Dionysius,	4 55 21
11 Copernicus,	1 59 10	2 0 5	29 Pliny, -	4 57 38
21 Tycho, -	2 0 48		27 Possidonius,	4 59 33
16 Timocharis,	2 10 25	2 11 39		
18 Archimedes,	2 13 55			
24 Manilius,	2 14 29	2 14 57		
17 Plato, -	2 14 42	2 15 45		
28 Dionysius,	2 16 21	2 16 26		
25 Menelaus,	2 17 33			
29 Pliny, -	2 20 35			
22 Eudoxus,	2 21 45			
23 Aristotle,	2 22 21			
32 Censorinus,	2 23 38			

2. *Occultations of Fixed Stars observed at Paramatta.*

1821,				
Dec. 14.	ξ Leonis, -	Immersion,	14h 49′ 9″,1	Mean Time.
		Emersion,	15 45 57	
Dec. 29.	* 7th magnitude, -	Immersion,	8 36 47	
Do.	do. -	Immersion,	8 46 47	
1822,				
Jan. 16.	* 7th magnitude Cancri,	Immersion,	16 8 6,9	
Do.	6,7 - -	Immersion,	16 54 19,9	
Mar. 28.	* 7th magnitude Tauri,	Immersion,	6 54 30,2	
30.	υ Gemini, - -	Immersion,	9 19 28,5	
April 1.	* 6th magnitude Cancri,	Immersion,	8 58 21,78	
10.	Antares, - -	Immersion,	18 35 47,4	
		Emersion,	19 14 27,9	

July 10.	* Piscium, - -	Immersion,	2	1	0,45	Sider. Time.
Aug. 16.	Eclipse of the Sun, -	Immersion,	19	35	36,32	Mean Time.
		Emersion,	22	8	40,60	
Oct. 22.	- -	Immersion,	22	29	9,8	Sider. Time.
1823,						
Jan. 20.	1 θ Arietis, - -	-	5	47	55,75	
Feb. 4.	Antares, - -	Immersion,	17	56	9,88	
		Emersion,	19	17	57,38	

3. *Eclipses of Jupiter's Satellites.*

1821,					
Dec. 8.	Emersion, - -	12^h	20′	25″,5	I. Satellite, Mean Time.
14.		12	5	13,3	II.
1822,					
Jan. 8.		9	11	42,8	II.
9.		9	1	17,2	I.
Aug. 16.		15	21	44,85	II.
16.		18	16	31,85	I.
Dec. 13.		10	13	53,0	I.

4. *Comparison of Observations for the Longitude.*

Of the Occultations, only those of Antares and the Eclipse of the Sun are calculated (by Comp. with N. A.): the Longitude of the Observatory at Paramatta thence inferred will be,

		Longitude of Paramatta.		
Occultation of Antares, April 10. 1822,	per Immersion,	10^h	3′	56″,0
	per Emersion,	10	4	7,42
Eclipse of the Sun, August 16. 1822,	per Beginning,	10	4	30,1
	End, -	10	4	17,2
Occultation of Antares, February 4. 1823, per Immersion,		10	3	59,1
The Emersion was too late in being observed.				
Longitude by a great number of Lunars, - -		10	4	5,13
Longitude of the Observatory at Paramatta,		10	4	9,16

Art. VIII.—*An Account of a Map of Koshanpri.* By Francis Hamilton, M. D. F. R. S. & F. A. S. Lond. & Edin. With a Plate. Communicated by the Author.

THIS Map of Koshanpri, Plate VIII. or of the country of the Shanwas or Mrelap-shan, I obtained from the slave to the then heir-apparent of the kingdom of Ava, who has been already often mentioned. Of the country which it represents, I have previ-

ously given some account (Phil. Journ. vol. iv. p. 266. v. 23.); and I may here remark, that the compiler excludes all the towns on the Erawadi from the territory of the Shanwas; nor does he include, in this map at least, the territory of Junzalæn mentioned by the native of Taunu (Phil. Journ. vol. v. p. 23.), although that town is certainly much nearer Kiainghan and Mobiæh or Mobræh, than is represented in the map by the native of Taunu, who introduces an immense empty space between these Shan towns and his native country, in order probably to leave room for its territory being considered more ample.

The territory of the Shanwas, if we include Junzalæn, but exclude the towns on the Erawadi, extending probably from about Lat. 17° N. to where the Mringngæh leaves China, north from Tunbain, in about Lat. 24° 40′ N, will be 460 geographical miles (60 to the degree) in length. Its breadth is in no proportion, as the Saluæn cannot be more than between 80 and 90 geographical miles east from Ava, and the mountains of the Shanwas appeared to be about 30 miles from that city, leaving only from 50 to 60 geographical miles for the width of this territory. This breadth continues from about the latitude of Ava to that of Taunu, a distance of about 186 miles, and gives a square area of about 10,000 square geographical miles. As from these two latitudes, towards each extremity, the territory narrows very much, the 274 remaining miles of length cannot be estimated at giving more than 7000 square miles, especially as the northern extremity around Boduæn, being a territory alternately occupied by China, Ava, and Laos, can scarcely be included in either. Farther, of these 7000 miles, a very large proportion seems to be occupied by forests; and it is chiefly in the 10,000 square miles between the latitudes of Ava and Taunu, adding perhaps 2000 square miles on the Mringngæh north from Ava, that we are to look for the cultivated territory of the nine cities of the Mrelap-shan or Shanwas, who are the great Siamnese (Tay Yay) of Loubere, and probably the Kalminham of Mendez Pinto, as I have already mentioned (Phil. Journ. v. ii. p. 267.), although they call themselves simply Tay, as if they were the only people entitled to this name.

The Shan cities on the Erawadi, which the slave, in compiling the general map, published in the second volume of this

Journal, included in the territory of the Mrelap-shan, he excludes in this particular map of that territory, which confirms what I have already said on that subject (Phil. Journ. vol. iv. p. 31.); and in this case the proper territory of the Tailung, or Kasi Shan, must have been larger than even the proper kingdom of Ava. But, although the princes of the Tailung (Nora of Asam) may have at one time governed this large territory, and even extended themselves along the Brahmaputra to Asam, to which they gave princes; yet their territory seems always to have been chiefly inhabited by rude tribes, and these seldom thoroughly subjected to the princes of the Shan race.

It is much to be regretted, that the compiler did not lay down any of the rivers by which this territory is watered. They are, I understand, numerous. He also represents as a mere ridge the hills bordering the kingdom of Ava on the west, concerning which I have already given my opinion, (Phil. Journ. vol. iv. p. 85).

The Shan men, it is said, never work, and it would be considered as a thing very shameful to a woman for her husband to be seen at labour. The men continue all day in the house sleeping and smoking, while the women toil in the fields. These poor creatures shave their heads, which, with their hard labour, must in a great measure destroy their personal attractions, and thus reduce them to mere drudges. The cultivators do not live in villages, as is usual in India and Ava, but in scattered habitations. Their chiefs or zabuas have large cities, from whence they take their titles, and are hereditary; nor are they usually removed from their office, except when a complaint is made by their subjects to the King. Should the complaint be judged well founded, the next heir succeeds. In cases of mental imbecility, or minority, the King appoints a temporary regent. They pay a fixed tribute, and at the Court of Ava take precedence of the Wungris or principal ministers, although they have no authority except in their own territories.

I did not learn the proper names of the Koshanpri or Nine Provinces of Shan, which are usually mentioned in the King's titles, and which, I understood, alluded entirely to the territory of the Shanwas, although, when we were at Ava, I had reason to think, from other authority, that this territory had been sub-

divided into eighteen lordships, governed by so many chiefs (zabuas), thus rendering these tributaries less formidable. The slave even alleged that this number had been increased to twenty-two, viz. Taunbain, SEINNI, Sounzhæh, Sibo, Main Doun, Main Gain, Rapzauk, MAIN PIEIN, Læhkhia, Puefla, GNAUNBUE, Sigiit, Naumnun, *Kiainkoun*, Zaga, Kiainghan, MOBRÆH and *Junzalæn*, of which those in Italics are not included in this map, and those in capital letters are powerful chiefs. *Kiainkoun*, however, I have little doubt, is the same place with that called Kiaintoun in this map, and in that published in the fifth volume of this Journal, the characters being very much alike. Junzalæn, therefore, in a detached corner between Pegu and Siam, is perhaps the only place of note here omitted.

On the whole, the relative situations and bearings of the places in this map, seem to deserve more attention than those in the maps by the native of Taunu (Phil. Journ. vol. iv. p. 2.); but a careful comparison of the distances in both authorities, as well as in several others, will be necessary to give any confidence.

The last place in Ava proper on this map is called Zabbhæhnago, but that town is on the opposite side of the river, and it is the custom-house that is laid down here, as well as in the map by the Zabua of Bhamno (Phil. Journ. v. iii. p. 40). In the map of Asia, Mr Arrowsmith mistaking Z for L, Zabbhæhnago has been called Labenagoa; but it has been placed on the proper side of the Erawadi, only a great deal too far north.

The ruby mines laid down NE. from Zabbhæhnago are nearly in the situation where the native of Taunu places Momeit, as I have mentioned in the account of his map (Phil. Journ. vol. iv. p. 86.); for they are about as far from Zabbhæhnago as the latter is from Amarapura, that is about 60 miles; but Baba Shean, the Armenian who managed the revenue of the great province of Hansawadi, and who escorted the British Embassy, said, that these mines were nearly opposite to Kiounmraun, and, of course, should bear SE. from Zabbhæhnago, and not NE., as represented in this map. At any rate, they are among the mountains of the Shanwas, and in that great forest, which is situated between the cultivated banks of the Erawadi and those of the Mringngæh, and which has been called Pahimapan (Phil Journ, v. iii. p. 267. v iii. p. 85) The distance between the Era-

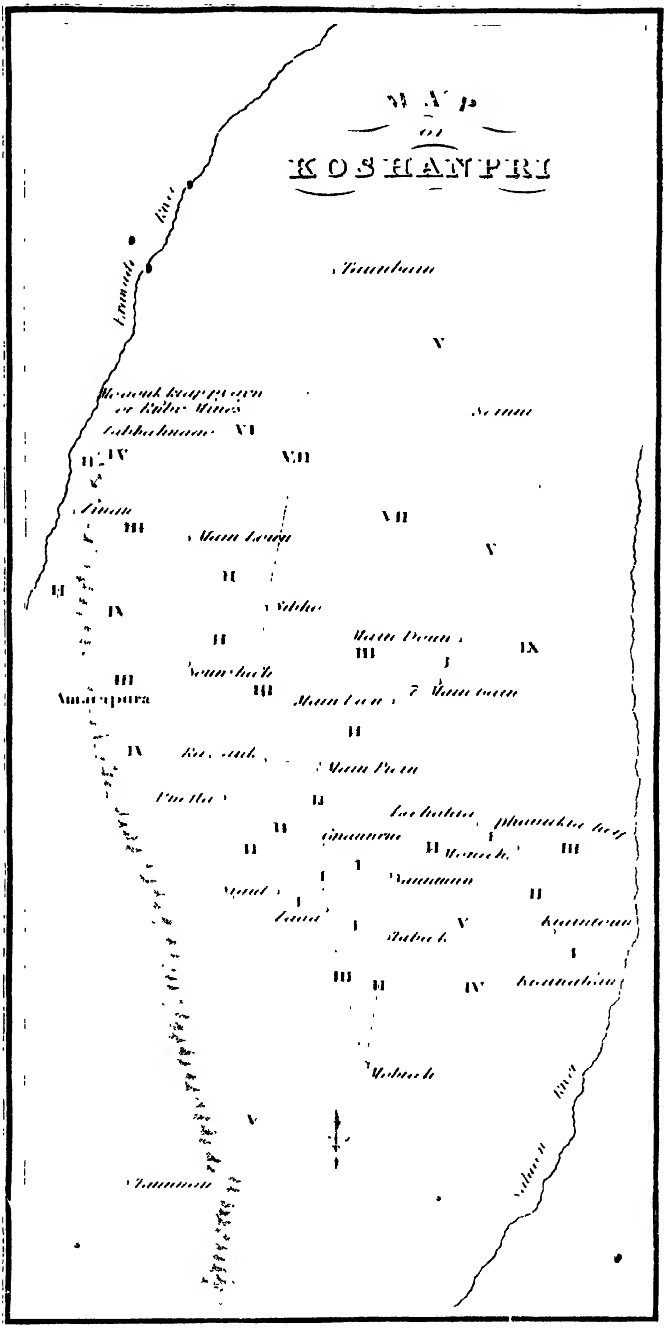
wadi and Mringngæh, running parallel to each other from north to south, may be 38 geographical miles, and allowing 10 miles on the side of each river to be a cultivated valley, we shall have 18 geographical miles for the width of this forest, and its length from north to south is probably about 70 miles. All the rude tribes occupying this mountainous space, and the valleys winding through it, seem to be subject to the Zabua of Momeit, who is one of the most considerable chiefs of this title; but he seems to have been included by the slave among the Shan of the Tailung race, as he is not mentioned in this map, representing the Shanwa or Mrelap Shan territory (Phil. Journ. vol. iv. p. 81).

Between the Mringngæh and Saluæn, is also a space of about the same width, the whole of which, after leaving the valley on the banks of the former, seems at one time to have belonged to Laos; and among its mountains towards the north are the valuable mines of Boduæn, taken not long ago from the Chinese (Phil. Journ. vol. iv. p. 79.), and producing gold, silver, and rubies. The southern part of this space is occupied by the Shan called Palaun, who pickle tea-leaves (Phil. Journ. vol. iv. p. 86.), and are probably subject to the Zabua of Seinni, a powerful chief, whose capital is placed between the Mringngæh and Saluæn, near where the territory of the Shanwas widens to its full extent. Farther north it is chiefly confined to the valley of the Mringngæh, in which are Taunbain, Mainboun, Sibho, and Sounzhæh.

The most important situation in this map to ascertain is that of Dhanukia, the ferry on the route to Zænmæ. If we place the course of the Saluæn half a degree farther east than it stands in Arrowsmith's map of Asia, as I have proposed (Phil. Journ. vol. x. p. 63.), and take a situation on that river equally distant (thirteen days' journey) from Amarapura and Taunu, as represented in the accompanying map, we shall have this ferry in about 98° 20′ E. and in about 20° 40′ N., about 120 geographical, or 139 British miles, in a straight line from Amarapura and Taunu, and 90 geographical (104½ British) miles from Zænmæ. Farther, the day's journey on this map, in great distances, will give about 10¾ miles; from whence some estimate may be made of the real distances between the different places, by making a proper allowance for the winding of the roads and routes.

2

PLATE VIII.



ART. IX.—*Description of a Variation in the Form of Bent Tubes, formerly described, for experimenting on small quantities of Gases.* By Mr WILLIAM KERR. Communicated by the Author.

IN a recent communication * I described a simple form of a bent tube, very convenient for the collection and absorption of small quantities of gas. In the present paper, I beg leave to lay before the public the account of an apparatus, which differs in some respects from the former, but by which the gas evolved, at any period of an experiment, may be examined, unmixed with atmospheric air, without diluting the liquid in the apparatus, or in any manner disturbing the experiment going on. This apparatus is also a bent tube, and differs from my former in being open at both ends, and in having the second branch, or that corresponding to the shut branch of the tube formerly described, bent downwards a little above its middle, at an angle somewhat greater than that formed by the inclination of the two branches. In Fig. 7., Plate VII., A is the first branch, or that through which the materials are most conveniently introduced; B represents the ascending part of the second branch, and C the descending part of the same branch, which can be shut at its inferior end by the stopper D, or by cork coated with wax, to resist the action of acids.

When this tube is to be used, the extremity of the descending part of the second branch must first be shut by a stopper or cork, and the liquid poured into the first branch, till it has occupied the whole of the second. This may easily be done by a little address, in nearly the same manner as was described in my former communication, for filling a bent tube of the simplest form. The tube is now to be placed so, that its first angle shall be its lowest point, when the solid substance to be acted on is to be dropped into the open end of the first branch. This body will slide down to the lowest point, and, owing to the construction of this part of the tube being the same as that of the tube formerly described, the gas evolved will rise into the ascending

* Page 53, of this volume.

part of the second branch. As the gas accumulates in this branch, it displaces the liquid, which ascends in the other. The descending part of the second branch, however, will still remain filled with liquid, which is now to be run back into the first branch, by elevating the shut end of the tube somewhat higher than the second angle. In this manipulation, the spilling of liquid from the open mouth of the first branch, or the introduction of atmospheric air into the gas, through the same branch, may be avoided, because the second is greater than the first angle of the tube *.

When the operator wishes to collect any of the gas in a separate vessel, he dips the inferior end of the descending part of the second branch beneath the surface of water, or mercury, according to the nature of the gas evolved. The stopper or cork D is then to be taken out, when the gas will issue from the mouth of the tube. When a sufficient quantity of gas has been collected, the stopper or cork is replaced.

Several tubes, such as have been just described, may be placed in longitudinal slits made in a wooden board, which, for the sake of convenience, should be attached in a horizontal position to the upper edge of one of the sides of an oblong pneumatic trough. A trough and shelf of a convenient size, together with one of the tubes in its place, are represented in Fig. 8. The internal measurement of this trough is 7 inches in depth, the same in width, and 10 in length. E is a horizontal shelf, with 4 slits, for holding the same number of tubes. The extremities of this shelf rest on the end-boards of the pneumatic trough, prolonged beyond the trough itself. Within the trough, and on the side next the shelf for holding the tubes, another shelf F is placed, like the common shelf in a pneumatic trough, at the depth of an inch or two. This shelf runs the whole length of the trough, viz. 10 inches, is $3\frac{1}{2}$ inches broad, and has slits cut in it corresponding to those in the other shelf. When any of the gas is to be transmitted from one of these tubes into a receiver, this is

* That is, the recurved part C forms a greater angle with the ascending part B of the same branch, than the two branches do with each other, though the last mentioned angle may be taken for the greatest, because it is more rounded,—or rather, the vertex of this angle is not formed, the two branches being united a little higher by a small portion of tube, in a position nearly horizontal.

placed on the shelf within the trough, the descending part of the second branch dips beneath it through one of the slits in that shelf, and, on the stopper D being withdrawn, the gas ascends from the tube into the receiver. Wine-glasses and small phials may be conveniently employed as receivers. If a mercurial, instead of a water, pneumatic trough be employed, the gas within the tube may not be able to make its escape through the descending part of the second branch, on account of the pressure of the mercury; but if the upper orifice of the first branch be corked, the gas will be forced to pass along its proper course. When the experiment requires the application of heat, a pot filled with hot sand may be placed beneath the shelf E, the curvature of the tube being sunk in the sand.

The descending part of the second branch should be of such a length as to dip beneath the surface of the liquid in a pneumatic trough, and, if the whole tube be 10 or 13 inches long, the length of this part should be from 2 to 2½ inches. This part must be shorter than the ascending part of the same branch; for when the stopper is taken out, in order to procure gas, the pressure of the atmosphere becomes equal on the surfaces of the liquid in the first branch, and in the ascending part of the second; the liquid, of course, rises to the same perpendicular height in both. If both parts of the second branch were equal, some of the liquid might pass over the second angle, and be lost in the pneumatic trough. The first branch should be large enough to hold the whole of the liquid contained in the second, so that when the inferior orifice of the descending part of the second branch is closed, there may be no danger of the accumulation of gas forcing a quantity of liquid out at the upper orifice of the tube. After the tube is made, if the first branch is found to be not sufficiently capacious, it may be made to hold more liquid by blowing out part of it into a globular form, as represented in the figure.

The tube which I described in a former communication *, and the one which I have described in the present, being both bent, it will be necessary to give to each a distinct name. Perhaps the name *Sealed* Bent Tube may be appropriately applied to the first, and *Open* Bent Tube to the present contrivance.

* See p. 53 of this volume.

The structure of the open bent tube may be somewhat varied, and the tube be still equally adapted to its purpose. Thus the descending part of the second branch may be left open, and a stopcock placed in the second angle.

The advantages of the open bent tube are nearly the same, but greater than those of the sealed bent tube. The formation of the smallest quantity of gas is detected by it, and the great advantage is gained of being able to ascertain the nature of the gas evolved at any period of an experiment, unaltered by atmospheric air *.

About two years ago, while endeavouring to discover the quantity of oxygen in the yellow and red substances produced by exposing phosphorus to heat, or for a long time to light, I thought of such tubes as I have described in my first communication, in order to detect with accuracy the quantity of gas evolved by the action of nitric acid on the substances mentioned. My inquiries did not prove altogether satisfactory, but I soon found that the tubes were exceedingly convenient for performing

* After the account of the sealed bent tubes was corrected for the press, I observed, in Dr Ure's Chemical Dictionary, under the article Carbonate, an account, which had previously escaped my notice, of an instrument invented by him, which bears a considerable resemblance to mine, though it is only adapted to a particular case. He recommends it exclusively for discovering the quantity of gas disengaged from a carbonate, by means of muriatic acid. It consists of a glass-tube, of the same strength and diameter as that usually employed for barometers, having one end blown out into a strong egg-shaped bulb, about 2 inches long, and 1¾ inch wide. The tube is recurved like a syphon, and its other end is left open. In using this instrument, the Doctor first introduces a small bit of the carbonate into the empty tube, and makes it slide along to the globular part. The whole tube is then filled with mercury, through which he subsequently contrives to pass a quantity of diluted muriatic acid, sufficient to dissolve the carbonate. As diluted muriatic acid has no action on mercury, at ordinary temperatures, all the gas evolved must be carbonic acid; and, as the Doctor ascertains the capacity of the bulb, and graduates the straight part of the tube between the bulb and the bend, he is able to determine with great accuracy the quantity of carbonic acid contained in calcareous spar, and some other carbonates. But as the curvature of his instrument is not dilated toward its shut branch, any gas evolved near that curvature cannot be collected with any degree of accuracy. In order to collect gas with his instrument, mercury must be employed, to confine both the acid and the substance acted on to the shut branch; therefore, it can be of no use when the acid employed acts on mercury. The tubes recommended by me can be employed in experiments with almost any acid.

Fig 5

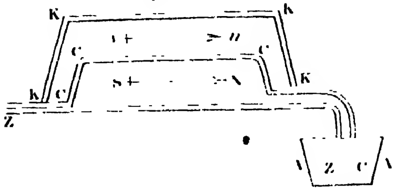


Fig 11

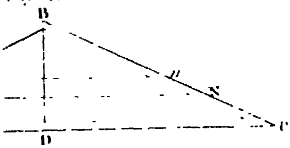
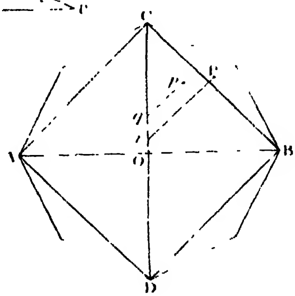
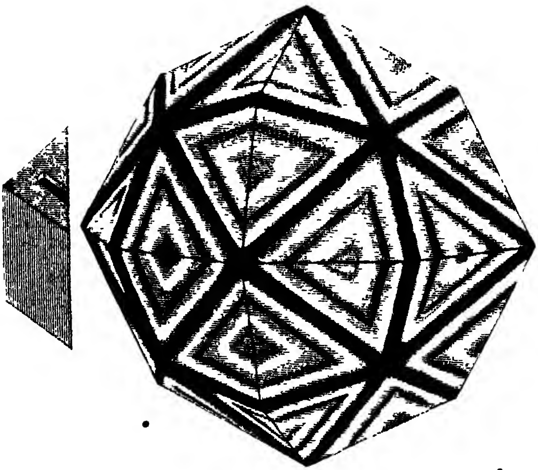


Fig 9



ANALCIME

Fig 10



experiments with a considerable degree of accuracy, on the evolution and absorption of almost any kind of gas. Subsequently, finding that it was often desirable to ascertain the quality of gas evolved at different stages of a process, I thought of the variation which is the subject of the present paper.

PAISLEY, }
December 2. 1823. }

ART. X.—*On a New Species of Double Refraction, accompanying a remarkable Structure in Analcime.* By D. BREWSTER, LL.D. F.R.S. Lond. and Sec. R. S. Ed.* Communicated by the Author.

THE mineral to which the Abbé Haüy has given the name of *Analcime*, has been ranked among those crystals which have the *Cube* for their primitive form. No distinct cleavage-planes, however, so far as I can learn, have been observed in it. Crystallographers presumed that such planes must exist, and, allowing conjecture to supply the place of observation, they considered Analcime as differing in no respect from other crystals of the same series. This opinion was first rendered doubtful by the observation which I made many years ago, that at thicknesses of $\frac{1}{25}$th of an inch, it displayed a considerable action upon polarised light; but though this fact indicated something singular in its organization, yet, owing to the great difficulty of obtaining proper specimens, I have been baffled in repeated attempts to investigate its structure.

Having lately received from the Rev. Dr Fleming some very transparent crystals of Analcime from the Macdonalds' Cave in the Island of Eigg, and having also been favoured with a very fine specimen from Montecchio Maggiore in the Vicentine, through the liberality of Mr Heuland, I have been enabled to resume the inquiry, and have obtained the results which it is the object of this paper to describe.

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* This paper is an abstract of the original one, which was read before the Royal Society of Edinburgh on the 7th January 1822, and will appear in Vol. X. Part I. of their Transactions, which is on the eve of publication.

The most common form of the Analcime is the *icositetrahedron*, a solid contained by *twenty-four* equal and similar trapeziums, and formed by three truncations on the eight solid angles of the circumscribing cube. If we suppose this cube to be dissected, by planes passing through all the twelve diagonals of its six faces, it will be reduced into *twenty-four* irregular tetrahedrons. The same planes divide the icositetrahedron into twenty-four similar *pentahedrons*.

If we transmit polarised light through the mineral in a direction perpendicular to any of the faces of the cube, we shall find that all the dividing planes now mentioned, are planes of no double refraction and polarisation, that is, that they consist of an infinite number of axes parallel to the four axes of the solid.

When any of the axes of the cube are placed in the plane of primitive polarisation, the tints will disappear, and continue invisible while the crystal is made to revolve round that axis; but when the axis is inclined 45° to the plane of primitive polarisation, or when the diagonals of any of the cubical faces are in that plane, we observe a black cross AB, CD, Plate VII. Fig. 9. separating four luminous sectors covered with the tints of polarised light.

In order to determine the character of these tints, we have only to cross them with the axis of a plate of any crystal, the character of whose action is determined. When the polarised tints are crossed by a plate of sulphate of lime, having its axis inclined 45° to the arms of the black cross, the tints all descend in the scale, and consequently the polarising action of the crystal is *Negative* in relation to each of the four axes of the icositetrahedron.

In every part of the crystal, the polarised tints are exactly those of Newton's scale, and have all the properties of the tints of moveable polarisation.

From an attentive consideration of the experiments, as detailed in the original memoir, it is obvious that the phenomena of the tints exhibited in any individual sector, Plate VII. Fig. 9., have no relation to the axis of the icositetrahedron passing through O, considered as an axis of double refraction. The axis of polarisation of every portion in each sector, as COB, is, on the contrary, perpendicular to the line CB, or parallel to one of the rectangu-

lar axes of the icositetrahedron, which is perpendicular to the axis passing through O. The tint of any point p, for example, does not depend upon its distance pO from O, but upon its distance $p\,q$ from the nearest plane of no polarisation, taken in a direction perpendicular to CB. Calling T, then, the tint, as determined by experiment, of any point P, whose distance P r, taken in the manner now mentioned, is D, we shall have the tint t at any other point p whose distance $p\,q$ is d,

$$t = \frac{\mathrm{T}\,d^2}{\mathrm{D}^2},$$

the thickness of the crystal being supposed equal at both these points. The polarising structure, therefore, of any two opposite sectors, is the same as if it were produced by compression, the axis of pressure coinciding with the axis of the icositetrahedron perpendicular to CB, and to the axis passing through O.

This remarkable structure produces a distinct separation of the ordinary and extraordinary images of a minute luminous object, when the incident ray passes through any pair of the four planes which are adjacent to any of the three axes of the solid. The least refracted image is the extraordinary one, and consequently the doubly refracting force is *Negative*, like that of *calcarcous spar*, in relation to the axis to which the refracted ray is perpendicular.

In order to convey some idea of the remarkable structure of Analcime, I have represented the planes of no double refraction and polarisation, and the tints of the intermediate solids, in Plate VII. Fig. 10. The dark shaded lines are the planes of no double refraction and polarisation, and the faint shaded lines represent the tints. The appearances, however, shewn in this figure, can never be seen by the observer at once, but they will assist the reader in following the experimental details, and in forming a correct notion of the phenomena.

One of the most important results of these experiments, is the singular distribution of the doubly refracting force, not merely in the crystal considered as a whole, but in each of the separate pentahedrons which compose it. In all other crystals in which the laws of double refraction have been studied, the axis to which the doubly refracting force is related has no fixed locality in the mineral. It is a line parallel to a given line in the primitive

form, and every fragment of a crystal, however minute, possesses this axis, and all the optical properties of the original crystal, however large. The property of double refraction, in short, in regularly crystallised substances, resides in the ultimate particles of the body, and does not depend upon the mode in which they are aggregated to form an individual crystal.

In Analcime, on the contrary, we have planes of no double refraction, having a definite and invariable position, and we may even extract a portion of each separate pentahedron which has no axis at all.

Nor has the doubly refracting structure of Analcime any relation to that of composite crystals, such as the *bipyramidal sulphate of potash* *, which consists of several individual rhomboidal prisms, beautifully combined to form a regular geometrical solid, or that still more complicated mineral *apophyllite*, where an individual crystal with one axis is symmetrically united with several individual crystals with two axes, so as to constitute a regular crystal †. In these, and other cases, each individual crystal that enters into the combination, retains its own character, and, considered by itself, possesses the ordinary properties of double refraction.

The Analcime partakes of the character of other composite minerals, in so far as it is made up of twenty-four individual pentahedrons; but each pentahedron possesses a new species of double refraction, which has been found in no other crystal. This structure resembles, to a certain degree, that of rectangular plates of glass, while in the act of being heated, in having the phenomena related to planes of no double refraction; but the resemblance goes no farther, as the structure of the glass depends upon its external form, and the planes of no polarisation change their position with the outline of the plate. In Analcime, on the other hand, the structure is permanently fixed, and has no relation whatever to the external shape of the fragment.

In the absence of more striking analogies, we may consider this structure as resembling that which is produced by hardening Isinglass, when in a state of compression or dilatation. In

* See this Journal, vol. i. p. 6.

† See this Journal, vol. i. p. 1; and *Edin. Trans.* vol. ix. p. 317.

this case the isinglass retains a fixed doubly refracting structure, related to the axis of compression or dilatation; and if it were cut into pentahedrons, similar to those of the analcime, we might combine them together, so as to imitate, at least in the direction of one of the axes, the phenomena exhibited by the mineral.

The property which has now been described becomes *an infallible and easily applied mineralogical character for Analcime.* However shapeless be the fragment, and however much obliterated be its external faces, its action upon polarised light will instantly determine whether or not it belongs to this species.

Haüy first observed in Analcime the singular circumstance of its yielding no electricity by friction, and he even derived its specific name from its want of this property. If we consider that the crystal is a combination of solids of variable density, and separating from one another by numerous intersecting planes or nodes, where the variations of density change their direction, we may ascribe to this cause the difficulty with which friction decomposes the natural quantity of electricity which resides in the mineral.

ART. XI.—*Journal of a Tour to the Coast of the Adriatic Sea, and to the Mountains of Carniola, Carinthia, Tyrol, Saltzburg, and Bohemia, undertaken chiefly with a view to the Botany and Entomology of those countries.* By Dr DAVID HENRY HOPPE and Dr FREDERICK HORNSCHUCH. (Concluded from p. 91.)

"WE gathered besides, to-day, plants of *Euphorbia dulcis, Lamium Orvala, Orchis pallens, Æcidium Anemonis*; and, on the hills of Monte Spaccato, in our return, we got a rare *Scorzonera* with narrow and broad leaves, which is probably Clusius's *Scorzonera pannonica*, var. *latifolia et angustifolia.* There grew also, in large quantities, an unknown and very beautiful *Senecio*, with undivided leaves and a single stalk.

"The Emperor went to-day to the cave of Cornial, where our host waited on him, as king of the grotto. Our astonishment was excited by a couple of large stalactites, which he brought from thence with him. They are 2 feet long, of a yellowish

honey colour, and foliated throughout with crystals. M. Brandenbourg fetched also a smaller pair for us, as a remembrance to us of this interesting cavern, which indeed we have not yet visited, and which we fear that want of time will now prevent our seeing.

" *Hundsberg, May* 5.—This day was fixed with our friends Brandenbourg, Gerop, and Nauwerk, to be employed in making an excursion of 3 stund to the distant ruins of Servolo. For this purpose, our companions came to us last night, slept here, and rose this morning as early as four o'clock. We proceeded, by a constant ascent, out of the valley towards the brook. In the hedges, and under the bushes, grew plentifully *Asparagus officinalis* and *Tamus communis*. This last was not in flower. We soon reached the road that leads to Fiume, but immediately quitting it, took that which conducted to Ritzmann, in which we found nothing that interested us. Thence we proceeded by the Karst to the remains of a Roman aqueduct, about a stund distant. The country here has the peculiar character of the Karst, being nothing but a series of barren limestone rocks, so hardened by the sun, that they are quite sonorous; and, from their uniformly grey tint, and also their jagged outline, they exhibit such a dreary aspect that one might imagine that the Creator's primeval curse had fallen most peculiarly on this district. In a valley above the aqueduct, where nought is visible but this unproductive waste of limestone, we contemplated with astonishment the country around us, on which, here and there alone, a starved plant is seen to spring up from the crevice of a rock, impelled by its own vitality: and we seemed to gaze with additional interest on the vegetation which gratified our sight, when we once more gained a space from whence we might behold the verdant coast. In all this weary waste, not a single insect was to be met with.

" We now proceeded to Tolino, which is charmingly situated at the foot of the mountain whereon stands the Castle of Servolo. On our way thither, we observed *Aristolochia rotunda* and *A. clematitis* growing plentifully under the hedge. The vegetation here was more luxuriant than on those limestone rocks in whose fissures we had, however, detected *Plantago subulata* (Wulfen.), *Mentha Pulegium*, *Saturcja montana*, and the broad-leaved

Scorzonera. Upon the flowers of *Prunus Mahaleb,* we found *Clythus hieroglyphicus* and *Cerambyx Cerdo.* We stopped at Tolino; and, during our breakfast, drank some glasses to the health of our sincere friends at Fichtelberg, ordered dinner, and then ascended to take a view of the ruins. The path led through an oak wood; and this side of the mountain was indeed entirely clothed with green shrubs; but, on the summit, we again found the stony waste, which, throughout its whole extent, the Karst always exhibits to a greater or less degree. From the ruins is a charming prospect of Carniola, Istria, and Friaul, backed by the sea. When the sky is cloudless, and the atmosphere clear, Venice may be seen with the help of a glass. To-day the heavens were lowering, and the whole country so clouded, that we could not, from this noble situation, enjoy the advantages that it would otherwise have afforded. Our view was confined to the adjacent parts of Istria, the sea, and its shore, Trieste, with its surrounding plains, the Saline from Saule, and the Valley of Masculi, presented to us several picturesque objects. Monte Nanas, and the mountains of Carniola bounded the prospect to the north; and eastward we could see nothing but the steppes of the Karst. We visited also a cavern, which, lying in the neighbourhood of the ruins, is said to have been the place of refuge of St Servolo, and in which an altar is erected to his honour. Besides the common plants of the Karst, such as *Alyssum montanum* and *Thlaspi saxatile,* we found nothing. We therefore soon descended to Tolino, where we dined, with an excellent appetite, and relished the wine of Istria. The wine-measure of Tolino pleased us well, it being larger than in any other part of the country. We returned over the meadows which lie between Tolino and Sante, where we gathered again the *Orchis variegata;* and, well contented with our day's journey, though Flora had acted much like a stepmother to us, we regained Trieste by the Sante road.

" *Hundsberg, May* 6.—Though we had a considerable quantity of plants to employ our time this day, yet we could not deny ourselves the gratification of witnessing the illumination which took place throughout the whole of this great city and its haven, occasioned by the presence of the Emperor. As we were proceeding in the evening towards Trieste, we much enjoyed the brilliant

spectacle which this flood of light afforded, as we viewed it from the summit of an adjacent hill. The promenade by the aqueduct, which we must always traverse in our way, was illuminated by large, many-coloured paper lamps; and numerous rockets ascended from the neighbouring plains. Amongst the buildings in the city, the Exchange, elegantly lighted, and decorated with various painted transparencies and inscriptions suitable to the occasion, was particularly conspicuous. Other edifices, private as well as public, seemed to vie with each other in taste and brilliancy. But the finest sight, at least in our opinions, was the coup d'œil presented by the illumination of the haven, with its mole and numerous shipping. Among these, some English merchant vessels peculiarly distinguished themselves. At a considerable distance out at sea, a pyramid was erected on a float, fixed by an anchor, which formed a complete blaze of light, and had a most striking effect. Numerous little vessels, hung round with gaily painted lamps, invited us to embark. We embraced this opportunity of gaining a nearer view of the pyramid; and, accompanied by two friends, we rowed thither, between a long row of brilliantly lighted ships, from whence we heard the gay songs of the sailors, celebrating the praises of the Imperial House of Austria. We surveyed from the sea this striking exhibition, which was enhanced by the incessant lightning that proceeded from an impending cloud. Scarcely had we time to regain the pier, when a sudden and violent storm arose, which instantly brought down the distant tempest in a tremendous torrent of rain, accompanied with thunder and lightning. This circumstance unexpectedly and instantaneously put an end to the illumination. We were glad to be able to reach the coffee-house Della Stella Polaris, though thoroughly soaked with wet; and we were unable, on account of the incessant pelting, to regain our quarters till past midnight.

" *Hundsberg, May* 8.—We were now obliged to bestow that attention upon our plants which should set us at liberty to make a fresh excursion on the following day. This extended over the meadows which encircle the hills of Monte Spaccato, and were those stony places enclosed with walls, of which we hardly knew at first what to think. Now, those barren spots are transformed into fields rich in flowers. Thousands of *Narcissis, Fri-*

tillaries, Hyacinths, Starch hyacinths, Scorzoneras and *Gentians*, adorned the ground; and we, moreover, found a couple of plants that were new to us, namely, a Valerian and a Plantain. The rooting up of some fifty specimens, was attended with much trouble in this stony ground. Besides these, there grow in this spot together *Globularia cordifolia, G. nudicaulis* and *vulgaris*, a circumstance which enables us to make an interesting addition to a treatise on the geographical distribution of plants, which we intend to pursue and publish.

"The little wood at the back of these meadows, consists of *Prunus Mahaleb* and *Pyrus Amelanchier*, among which were some single trees of *Sorbus domestica*. Here, also, the *Curculios* were quite at home: we found particularly *C. Gorzensis* and *C. planatus* together, in tolerable plenty: the great beauty and size of these specimens, induced us to collect them, though we had already got a sufficient supply of these species. The great affinity and proximity of habitat of these two insects, is a circumstance of a similar nature to what we have already noticed in the *Globulariæ*.

"*Hundsberg, May* 10.—It was late yesterday before we finished drying our *Valerians, Senecios* and *Plantains*; and we were, therefore, obliged to delay the examination of these plants till this morning. The *Valerian* has the habit of *V. dioica*, but its inflorescence is completely hermaphrodite. This circumstance certainly constitutes no specific distinction; for, according to Scopoli, even the *V. dioica* has, in Carniola and near Saltzburg, been often observed with hermaphrodite flowers. Better marks of difference are, therefore, those afforded by *stolonibus nullis et radice tuberosa*. In a word, this plant is a decidedly marked species, and yet appears to be unnoticed in any botanical publication, and omitted in every German Flora *. The *Plantago* we must also pronounce to be a novelty, which has probably been hitherto confounded with *P. lanceolata*. For the present, we will only observe, that plants of it are remarkable even at a distance, by their large round heads of flowers, beset with snowy white anthers, and on this account it might well deserve the name of *Plantago capitata*. The *Senecio*, we had determined as the

* It is the *V. tuberosa*.

S. lanatus of Scopoli, which, as this author has already observed, is very different from *S. Doronicum*. As, however, we know that another species appeared under this name in the System, we have chosen for this individual the name of *S. Scopoli*. To-day we have transacted our business in the city, and hope to be able to make a farther excursion to-morrow.

" *Hundsberg*, *May* 11.—An excursion was made by us to-day to the wood of Lippiza. This place, never to be forgotten by us, or by any other botanist who has visited it, now appears in its full glory. The *Pæonia*, with deep red single flowers, is in full blossom, and from the profusion of its inflorescence, it forms a really beautiful sight. All the plants which we had found in our earlier perambulations through this sanctuary of Flora; are now in abundance, even those of the Karst of Contobello; so that the wood really forms a botanic garden, wherein the vegetable inhabitants of the adjacent country are assembled. This is owing to the locality of the wood, of which we shall now attempt to give a particular description. One must not, from the term of the Wood of Lippiza, imagine that it is at all like our oak and beech woods; for the nature of the soil does not admit of the growth of these thick forests. It consists, on the contrary, of separate groups of trees and shrubs, between which are seen open spaces, which are sometimes only covered with bare stones, but which sometimes form verdant plots, that serve as pasture for horses. It has, also, another peculiarity, in those deep excavations common in all the Karst country, which are partially cultivated, or form moorish spots. Each of these different situations produces plants peculiar to itself. The shrubby parts abound with plants that seek the shade, as *Lamium Orvala*, *Melittis grandiflora*, various species of *Convallaria* and *Lathyrus*, &c.; whilst, close by, the grassy spots are covered with large and beautiful specimens of *Globularias*, of *Scorzoneras*, and *Polygala vulgaris*. In the deep, wet grounds, grow the *Aristolochias* and some kinds of *Orchideæ;* and the bare stones protect the *Alyssum montanum*, the *Genistæ*, and other productions of the Karst. Among the more remarkable shrubs, are the *Manna-Ash*, (which, however, is very plentiful here). *Euonymus latifolius* and *E. verrucosus*. These nourish several kinds of insects, of which we got a large flock to-day. We found many specimens of *Carabus catenatus*,

and also of *C. convexus*, *Calosoma Sycophanta* and *C. Inquisitor*, *Lamia tristis*, *funesta*, and *pedestris*, *Albax Striola* and *ccrinotus*, *Cerambyx cerdo*, *Pterostichus fasciato-punctatus* (*Creutz*,) *Sarites Gagates*, *Curculio gemmatus*, *Mezerei F. Pincti F.*, and some new species: also *Gymnopleurus pilularis*, the golden green *Scarabæus vernalis*, and again the new species. In order to catch the *Carabi*, *Calosomæ*, and the new species of *Scarabæus*, we employ a peculiar kind of chase. These beetles secrete themselves under the fallen leaves, from whence they do not emerge till all around is quiet, when they seek for food or for their mates. We, therefore, tread very softly up and down by the bushes, and stand quite still, wherever we expect any thing. Whenever an insect moves, which is immediately known by the rustling of the leaves, we pay close attention to the spot whence the sound proceeds; and as soon as the beetle is seen, we dart upon it like lightning, the greatest promptitude being requisite to secure the creature, which instantly retires to its hiding place, upon perceiving any individual near.

" *Hundsberg*, *May* 13.—Having yesterday taken measures for the preservation of our plants and insects, we were enabled to go out again botanizing this morning, and we chose, for the spot which we would visit, the Chesnut Wood in our neighbourhood. At our first entrance, the two pentandrous plants, *Onosma echioides* and *Cynoglossum chierifolium* saluted us respectfully with inclined heads. In their train we found *Galium rubrum* and a *Potentilla*, which, in leaves and flowers, resembles *P. opaca*, but whose erect stem brings it nearer to *P. recta*. The plant which we know under the latter name in the Botanic Garden has a different appearance from this, bearing a much larger flower, of a fine brimstone colour. We also found here, far distant from the sea-shore, *Plantago subulata* and *P. Wulfenii*, in a fine state. Scattered though the wood in plenty grew *Fraxinus Ornus*, *Coronilla Emerus*, *Cratægus monogyna*, *Inula hirta*, *Melittis grandiflora*, *Tamus communis*, *Lithospermum purpuro-cæruleum*, *Vicia Cracca*, some *Genistæ*, and an *Ononis*, " *caule erecto inermi*, *floribus purpureis*." Amongst the scarce things were *Campanula spicata* and *Veronica austriaca*. We ascended to the top of the Karst and perceived a powerful odour, which proceeded from some plants not yet in flower, pro-

bably belonging to a *Hyssop* or *Savory*. Another plant that was plentiful throughout the whole Karst, but not in blossom, is *Lotus Dorycnium* (Linnæus), a *Salvia*, with the characters of *S. pratensis*, but with smaller inflorescence, and an unknown *Rhamnus* beginning to flower. Our entomological success to-day was also considerable. Within the blossoms of the *Manna Ash* were many *Cetoniæ*, and amongst them *Cetonia metallica*, as also, *Melolontha squamosa*, a small *Buprestis*, and a multitude of *Piezata*. On the ground in the wood, we found *Calosoma Inquisitor*, and under stones a beautiful specimen of *Carabus cyaneus*, *Scolopendra morsitans*, *Scorpio europæus*, and our new *Julus*. In the evening we were refreshed by the grateful smell that proceeded from the *Lonicera Caprifolium*, and from a *Silene*, whose flowers, closed by day, were only now expanded.

" *Hundsberg*, *May* 14.—The weather is at this present time remarkably fine; the great heat of day being in the evening mitigated by soft showers, whose influence gives luxuriance to the vegetable world, and new life and vigour to the insect creation. Thus, our daily labour receives no intermission, for we find, indeed, that many plants lose their bloom before we can lay them out. The *Silene* which we gathered yesterday is Host's *S. noctiflora*, a name which our yesterday's experience proves to be applicable. We almost doubt whether this plant grows in the middle of Germany, and we believe that the individual to which this name is given by Hoffmann and Roth is another species. A remarkable circumstance which we here noticed is, that the *Silene nutans* yields, at night, a very agreeable scent. Perhaps this climate has a powerful influence over our vegetables, for in the north of Germany this plant exhales no odour, at least we have never experienced it ourselves, nor met with any writer who noticed the peculiarity. The *Rhamnus*, which so much raised our expectation yesterday, is *R. rupestris* of Scopoli. Host refers it to *R. pumilus*, to which it certainly does not belong. We will only mention the following characters, until we can give, at some future time, other points of difference. *Rhamnus pumilus* grows upon a wall on the Schlossberg at Aschan, and is small, and a stunted specimen. In the same dwarfish manner, it inhabits the rocks of Sonnerwend-

stadt at Untersberg, and, according to Mr Von Braune, the walls of the fortification at Werten, which it covers like ivy. The plant here is found on stony Karst as a bush, and like a tree in the Chesnut wood, resembling in height *R. Frangula.* We have made a third discovery, which pleases us well, namely, that the supposed *Rhus* has changed itself into the *Turpentine Tree* (*Pistacia Terebinthus*). We did not expect this rarity to be so near. We would here recommend to the attention of the dendrologist these two species of trees, and to the florist the *Silene noctiflora;* we are sorry that we could get neither ripe seed nor perfect fruit. The botanical character of this southern part of Germany now begins to disclose itself, and it is quite striking how much two of the natural orders of plants predominate here, namely, the *Leguminosæ* and *Orchideæ. Orchides, Cytisi, Genistæ, Loti, Trifolia, Lathyri,* and *Medicagines,* are everywhere seen in great profusion and variety; and all the species of *Orchis* which are scattered throughout Germany may here be seen growing in a couple of fields. The genus *Euphorbia* here also produces very many species, of which but four appear in the middle of Germany. Thus, likewise, the families of *Labiatæ, Cruciferæ, Compositæ,* are especially natives of this country, and you cannot make an excursion without finding a considerable variety of them. It is likewise worth observing, that many common plants of the central parts of Germany are not to be seen here, but that their place is almost always supplied by others of a similar, or nearly allied genus. For instance, we find here

Arum italicum instead of	A. maculatum.
Echium italicum	E. vulgare.
Cynoglossum Cheirifolium	C. officinale.
Aristolochia longa	A. Clematitis.
Mercurialis ovata	M. perennis.
Fraxinus Ornus	F. excelsior.
Quercus pubescens	Q. Robur.
Carpinus Ostrya	C. Betulus.
Adiantum Capillus Veneris	Asplenium Trichomanes.
Ceterach officinale	Aspidium fragile.
Rhamnus rupestris	R. Frangula.
Cratægus monogyna	C. oxyacantha.
Lonicera Caprifolium	L. Xylosteum.
Prunus Mahaleb	P. spinosa.
Spartium junceum	S. Scoparium.
Euonymus latifolius instead of	E. europæus.
Clematis viticella	C. Vitalba.
Sorbus domestica	S. aucuparia.
Pulsatilla intermedia	P. vulgaris.
Leucojum æstivum	L. vernum.
Primula acaulis	P. elatior.
Helleborus viridis	H. niger.
Carex Schœnoides	C. Schreberi.
Carex extensa	C. flava.
Carex alpestris	C. montana.
Lolium tenue	L. perenne.
Triticum junceum	L. repens.
Bromus squarrosus	B. mollis.
Scorzonera austriaca	S. humilis.
Valeriana tuberosa	V. dioica.
Plantago capitata	P. lanceolata.

"*Hundsberg, May* 16.—Yesterday was dedicated to the drying of our plants, and to-day to seeking for plants and insects in the Wood of Lippiza. When we last had been there, we laid some bits of raw meat on the fallen leaves, in order to attract certain carnivorous beetles, but we found to-day only a couple of *Carabi catenati*, and a number of common *Silphæ*, particularly *S. lanata.* True *Necrophori* were not found there. As we are engaged again with insects, and our presses are filled with plants, we devoted this day wholly to entomology, and collected numerous *Carabi*, *Curculiones*, and *Scarabæi*, which are here very numerous. Besides these, we found *Chrysomela tristis*, *hemisphærica Andersch*, *Hottentotta*, *bicolor*, *Gættingensis*, *globosa*, *Clythra longipes*, plentifully on shrubs; *Cistela lepturoides*, *Lamia atomaria* and *tristis*, *Abax striola*, *striolatus* and *latus*, *Helops cœruleus et caraboides*, *Calandria abbreviata*, *Donacia nigra*, *Pedinus helopioides*, *Byrrhus Gigas*, *ornatus* and *coronatus*, *Mylabris Spartii*, *Curculio distinctus*, *variolosus*, *punctato-striatus*, *ophthalmicus*, *cribrosus*, *clypeatus*, *gemmatus*, *pincti*, which used only to be found in Sweden. *Curculio Mergerlei*, *Asida grisea*, *marginata*, *Cimex maurus*, *Cassida Murræa*, *Tetyra picta*, *Tenthredo Scrophularia*, *rustica*, *succincta* and *togata*, *Stratyomis Chameleon*, with many common and still more unknown *Curculios*, *Chrysomelas*, *Elaters*, *Piczatas* and *Dipteras*. We shall give the information regarding the new species in a supplement when we can get at our books, and can afford the necessary time to their examination.

" *Hundsberg, May* 18.—Having yesterday taken care of our plants and insects, and being desirous of getting something to store our presses before we take our journey into Istria, we divided our forces, the better to explore the country. One of us ascended the Karst, and, among other things, brought away the delicate *Cytisus argenteus*, as also some *Genistæ*, which are now coming into flower. The other, who went in the direction of Saule, found all the meadows there overgrown with the most noble specimens of *Schænus nigricans* and *Scirpus Holoschænus*, and intermingled with these, grew abundantly very luxuriant plants of *Orchideæ*. First of these must be named *Orchis palustris* and *Ophrys arachnites*. A violent thunder-storm drove us both home before the intended period of our return.

Hundsberg, May 20.—Yesterday should have been appropriated to visiting the lovely valley of Masculi in company with some of our friends, but the incessant rain frustrated our intentions. To-day we are obliged to go into the city, there to make some needful preparations for our journey, such as procuring passports, obtaining letters of recommendation, and taking leave of our acquaintance. By the kindness of our friends we obtained several useful recommendations, especially one from the Governor of the Circle, Count Carl Von Choteck, which is addressed to the various public offices in Istria; and which, we expect, will prove of essential service. As this last letter exactly shews how the higher ranks in Austria endeavour to promote science, and especially the study of botany; and also sets, in the fullest light, the kind attention of Count Choteck towards scientific travellers, we make no scruple to insert it verbatim. It was written in both the Italian and German languages as follows: "The bearers of this, Mr Professor Hoppe and Mr Apothecary Hornschuch, being designed to make a botanical tour in Istria, and being strangers in this country, and having asked letters of recommendation thither, I request all of you, Gentlemen Commissioners of the Circle, Agents, &c., to afford to these two mentioned gentlemen, now on their journey to Istria, every possible aid and assistance; and particularly, in such circumstances, as may promote the chief object of their journey. (Signed) Carlo, Comte di Chotek, Chamberlain, Knight of the Order of St Maurice, Privy Counsellor, &c., &c."

After we had provided the various articles which were requisite to our journey, we waited upon our worthy friend Brandenbourg, intending to pass yet one more pleasant evening with him, sincerely to thank him for the various marks of kindness which he had shewn us during our stay here, and earnestly to wish him success in his projected long voyage. Mr Brandenbourg is going in a few days in an Austrian frigate to Tripoli, there to demand from the Dey restoration of a vessel, which was captured last year in the Mediterranean by a corsair of Tripoli, and which belonged to our friend's family, and sailed under the Austrian flag.

"*Santo Nicolo, near Capo d'Istria, May* 21.—Though the early part of this day was ushered in with rain, yet we would not

allow this circumstance to prevent us from prosecuting our journey, and we had the pleasure to find that our hopes of the short duration of bad weather were confirmed by the event. About 8 o'clock we rambled towards the city and through a part of the old town, in order to reach that hill over which the road leads to Istria. Here the country begins to assume a mountainous and stony character. It consists mostly of fine-grained sandstone, but which is mixed with so much lime, that it has the property of effervescing with acid, and also of yielding sparks when struck with steel.

Many plants appeared, in the genera of *Verbascum*, *Reseda*, *Euphorbia*, and *Scrophularia*. The *S. canina* was abundant, along with the *Parietaria officinalis* and *Cynoglossum Cheirifolium*. In the meadows near Saule, we saw numerous plants of *Globularia vulgaris*, *Ophrys arachnites*, *Orchis palustris* and *variegata*, and a species of *Equisetum* which we did not know. On the marsh-banks, which divide the salt-marshes, were the *Tragopogon* and *Scorzonera*; and the sea-shore was bordered with *Scirpus palustris*, *compactus*, and *Tabernæmontanus*, growing with *Schænus nigricans*. Then we came to meadows full of our narrow-leaved *Leontodon*, and of orchideous plants; and when we had reached the first mountain behind Saule, we found a pasture quite clothed with flowers, entirely consisting of but two species, viz. *Leucojum æstivum*, and a very broad-leaved *Plantago lanceolata*, on which we must bestow a closer examination. The road now led over dry mountains, where nothing grows but the stone-plants already noticed, especially *Scrophularia canina* and *Echium italicum*. On grassy spots we found *Vicia grandiflora*, many *Trifolia*, *Crepides*, and particularly *Medicagines*; in moist situations, under hedges, grew *Carex pendula*. At length we caught a distant view of Capo d'Istria across the sea, and finally reached it by traversing a narrow neck of land, upon which we found a specimen of *Geotropes punctatus*. When we inquired for an inn, we were totally unable to get information of any, and therefore concluded that such kinds of houses were not to be met with here. In this dilemma, we determined to go immediately, botanically equipped as we were, to M. Von Madonizza, a nobleman possessing large property in the neighbourhood, and for whom a letter of introduction had been given to

us. This was a delicate business too; we come to a strange country, a strange town, and to a still stranger person, and, without scruple, request him to give us a lodging. Nor was this difficulty all; for M. Von Madonizza understands not a word of German or French, nor we a syllable of Italian. He is a rich nobleman, and we, poor botanists. What would be thought of it in our own country, if two strangers, habited in so singular, and yet mean, a manner, as we were, should come to trouble a gentleman, a perfect stranger, in his own house; and if more, they could not say what they wanted, what would become of the poor fellows! However, we proceeded towards the house with tolerable courage, and had scarcely reached it, when a well-dressed young man appeared, and received us with the words, "*Aha! botanici!*" He led us up stairs into an elegant apartment, invited us to be seated, and to disincumber ourselves of our luggage, in the most friendly manner. Now the first step was taken, and yet we felt very uncomfortable at not being able to address our hospitable entertainer; but M. Von Madonizza obviated this inconvenience by sending for an interpreter, through whose medium we readily communicated what we wished to say, and received much kind information from him in return. Our generous friend proposed to take us with him to his country-house, from whence we could examine the productions of the soil around, and we need hardly say that we accepted this offer with much pleasure. This villa was situated on the opposite shore of an arm of the sea, and we were conducted thither in a beautiful little vessel, accompanied by M. Von Madonizza and the interpreter. A basket replenished with a great variety of provisions was carried, and also a dozen bottles of wine. The passage was performed in a quarter of an hour. On the way, our kind landlord spoke of a beautiful plant, which grew abundantly in his fields, and whose name he was desirous to know; it proved to be *Orchis bifolia*. In the same situation we saw several other beautiful things, such as *Trifolium incarnatum, cæspitosum*, and *scabrum, Juncus maritimus*, &c. &c. Our benefactor seemed to take a considerable share in our enthusiasm and pleasure. We soon reached his house, and he led us about it and his garden. The noble situation of this fine stone-building, which, placed on a hill near the shore, com-

mands a delightful view of Isola, Pirano, and the sea around, really baffles all description. Before this dwelling belonged to the present possessor, it had been a convent of St Nicholas. Although the garden was chiefly laid out in the cultivation of vegetables and fruit-trees, there were yet many ornamental plants in it; and the hedges consist of *roses: sage* and *thyme* grow here to a noble size, and are now in full flower. But particularly we noticed, against the walls, such old and stout stems of *jessamine*, *rosemary*, and the *locust-tree* (*Ceratonia siliqua*), as we had never before seen. In the greenhouse, where, notwithstanding the forwardness of the summer, its inhabitants were still suffered to abide, we observed the common plants of such a place, as *Geraniums*, *Hydrangias*, *Lantanas*, and *Volkamærias*.

It was now evening, and M. Von Madonizza returned to the town, after having ordered his gardener to pay us all attention, shewn us the apartment where we should sleep, invited us to a well-furnished table, and repeatedly told us by his interpreter, that he would be happy in our remaining here as long as was agreeable to us."

" *Santo Nicolo, May 22.*—After breakfast to-day, we took a botanical walk, to examine the neighbourhood. From our new habitation we took to the eastward, over a mountain which is at some distance. Immediately behind the house we gathered *Hyacinthus comosus*, with rather an unusual habit; and in a pit close by grew a large *Carex*, much resembling *C. hirta*. We pursued a road which led into the country, having a bank clothed with bushes on its left side; here grew *Oak* and Hornbeam (the latter probably *Carpinus ostrya*), *Cratægus monogyna*, *Spartium junceum*, *Rhus cotinus*, and the *Common Elder*. Beneath were *Orobanche major*, *Hedysarum onobrychis*, *Lotus corniculatus* and *hirsutus*, *Hippocrepis comosa*, and *Plantago subulata* and *Wulfenii*. We followed the track of a murmuring brook, from both sides of which hung down bushes of the same description as those which I have named, entwined with *Coronilla Emerus*, *Lonicera caprifolium*, and *Clematis viticella*. On the leaves of the latter we found in plenty the fine *Æcidium Clematitis*. There were also *Lithospermum purpuro-cæruleum*, *Geranium sanguineum*, *Melittis grandiflora*, *Scabiosa sylvatica*, *Pteris aquilina*, *Polygala vulgaris*, *Scirpus romanus*, *Limodo-*

rum abortivum, and on wet rocky spots was *Adiantum capillus Veneris*. After we had followed our murmuring guide for some time, we found its sides becoming so steep, that we struck over the hills, one going to the left and the other to the right. Here we gathered the *Astragalus* of Trieste, the lovely *Cistus Helianthemum*, *Convolvulus cantabrica*, *Ulmus suberosa*, *Cnicus defloratus*, *Cytisus nigricans* and *argenteus*, and an unknown species of *Briza*, one new *Plantago*, and on oak-leaves a beautiful *Erineum*. When we reached the top of the hill, we found it remarkably barren. *Lamia pedestris* was not uncommon under stones. To our surprize we saw Trieste at a considerable distance, and Moja behind, at the foot of the mountain where we stood. In order to avoid going twice over the same ground, we turned towards a hill on the south-west, lying near the sea, where we found *Serapias ensifolia* and *Ophrys arachnites*. The heat of the day was great, and we encamped at noon under the shadow of some beautiful shrubs, of which *Castanea sativa* was the principal; and it was surrounded with *Colutea arborea Coronilla Emerus*, the undetermined *Cytisus*, and *C. nigricans*, on which *Tamus communis* climbed, whilst *Scabiosa sylvatica* cushioned our seat. After resting a while, we rambled yet farther, and emerged from the bushes into an open tract, where *Coronilla coronata* and an *Apargia* flowered; and *Scorzonera, latifolia* was in seed. At last we got into wet meadows by the sea-side, where the fine *Orchideæ*, which we had formerly noticed at Saule, were very numerous, as also *Carex distans*, and two other species of Host, with which a meadow was covered. While we were employed in digging up these, a country man, followed by a man and a woman-servant and a number of cattle, came running, to look at us! We asked for a draught of water; but this was, as everywhere in the vicinity of Trieste, extremely bad. Oh! when shall we return again to our own pure, cool, alpine springs! On our return, we observed, near a countryman's house, some beautiful trees of *Punica granatum*; and in a stone enclosure were *Aristolochia clematitis*, and a woody plant of the class and order *Monoecia Triandria*, having "*calyx trifidus, corolla nulla*," with the habit of *Thesium linophyllum*, and which is entirely unknown to us. Of insects, we collected *Clythra longipes*, *Cetonia metallica*, and some *Cimices*. When we came

back to the house about 5 o'clock, we saw our kind patron crossing in his beautiful little bark. He brought with him to-day another interpreter, who understood the German language better than the former. The plants in the greenhouse were now particularly reviewed, placed in order, and those which had not been named, were determined by us; no difficult task,—for though we had not our books with us, we were well acquainted with those which were the common kinds of greenhouse flowers. After having supped together, M. Von Madonizza took his leave, to go back to Capo d'Istria, after having promised to bring his lady with him the next day, and repeated his invitation to us to remain in his house as long as we might find desirable.

It was a glorious evening, such a one as only this cheerful month, in union with a soft southern climate, can afford. We enjoyed its charms, admired the noble prospects of this paradisiacal country, and lingered in the garden, employed in friendly conversation relative to our future plans, till past midnight."

This brings us to the termination of this interesting volume, and we regret, for the sake of science, that no more of the work is likely to appear. We shall conclude our extracts by giving a list of the first century of plants which these indefatigable botanists have published, and which include many individuals of great rarity, and which are preserved, to our own knowledge, in the most beautiful manner.

Plantæ Phanerogamæ selectæ, quas in locis natalibus collegerunt et exsiccaverunt D. H. Hoppe et Fr. Hornschuch. Ratisbon, 1817.

DECAS PRIMA.

Crocus variegatus, *H.* et *H.*
albiflorus, *Kitaibel.*
Primula longiflora, *Wulfen.*
glutinosa, do.
Lepidium brevicaule, *H.*
Braya* alpina, *Sternb.* et *H.*
Leontodon Taraxacoides, *H.* et *H.*
tenuifolium, *H.* et *H.*
Aristolochia longa, *Linn.*
rotunda, *Linn.*

DECAS SECUNDA.

Valeriana tuberosa, *Linn.*
Armeria alpina, *Willd.*
Gnaphalium carpathicum, *Wahl.*
Wibelia chondrilloides, *H.* et *H.*
Ornithogalum Liotardi, *Stern.*
Pulsatilla intermedia, *H.* et *H.*
Linaria alpina, *Persoon.*
Senecio Scopoli, *H.* et *H.*
Chrysanthemum montanum, *Linn.*
Mercurialis ovata, *St.* et *H.*

* A new genus of plants, of which an additional species has been discovered in Melville Island. The same, I may observe, has been the case with a genus of Mosses (*Voitia*), first found by these gentlemen during their travels. A second species of this genus has likewise been detected in Melville Island.—ED.

DECAS TERTIA.

Plantago Wulfenii, *Bernh.*
capitata, *H.* et *H.*
Ranunculus rutæfolius, *Linn.*
bupleurifolius, *Peyr.*
Trifolium scabrum, *Linn.*
Euphorbia veneta, *Willd.*
Epithymoides, *Jacq.*
Trifolium cæspitosum, *Ræm.*
Hieracium angustifolium, *H.*
pumilum, *H.*

DECAS QUARTA.

Rhamnus rupestris, *Scop.*
Genista sylvestris, *Scop.*
sericea, *Wulf.*
Astragalus monspessulanus, *Linn.*
Cytisus argenteus, *Linn.*
Dorycnium herbaceum, *Vill.*
Quercus pubescens, *Willd.*
Carpinus orientalis, *Lamarck.*
Osyris Ornus, *Linn.*

Plantæ Gramineæ selectæ, &c.

DECAS PRIMA.

Scirpus romanus, *Linn.*
compactus, *Krok.*
Schœnus nigricans, *Linn.*
Elyna spicata, *Schrad.*
Tofieldia alpina, *Sternb.* et *H.*
Luzula nigricans, *Desv.*
Carex Hostii, *Schk.*
extensa, *Host.*
alpestris, *Willd.*
capillaris, *Linn.*

Plantæ Cryptogamicæ selectæ, &c.

DECAS PRIMA.

Polypodium hyperboreum, *Sw.*
Ceterach officinarum, *Willd.*
Aspidium Lonchitis, *Sw.*
rigidum, *Sw.*
Oreopteris, *Sw.*
Aspidium aculeatum, *Sw.*
montanum, *Sw.*
Asplenium viride, *Huds.*
Blechnum boreale, *Sw.*
Adiantnm capillus, *Linn.*

DECAS SECUNDA.

Anictangium Hornschuchianum, *Funck.*
compactum, *Schw.*
Weissia compacta, *Schw.*
acuta, *Hedw.*
nigrita, *Hedw.*
Cynodontium capillaceum, *Hedw.*
Barbula tortuosa, *Schw.*
Trichostomum fontinaloides, *Hedw.*
Bartramia Halleriana, *Hedw.*
Œderiana, *Hedw.*

DECAS TERTIA.

Dicranum majus, *Schw.*
elongatum, *Schleich.*
virens, *Smith.*
Timmia austriaca, *Hedw.*
Bryum Schleicheri, *Schw.*
Leskea rufescens, *Schw.*
chrysoon, *H.* et *H.*
Polytrichum alpinum, *Linn.*
formosum, *Hedw.*
longisetum, *Swartz.*

DECAS QUARTA.

Splachnum urceolatum, *Hedw.*
gracile, *Dicks.*
Encalypta rhaptocarpa, *Schw.*
affinis, *Schw.*
Weissia fugax, *Hedw.*
Weissia crispula, *Hedw.*
Mielichoferi, *Funck.*
latifolia, *Schw.*
Trichostomum latifolium, *Schw.*
funale, *Schw.*

DECAS QUINTA.

Fucus spiralis, *Esper.*
concatenatus, *Linn.*
obtusus, *Huds.*
Conferva intestinalis, *Roth.*
Conferva Linum, *Roth.*
Conferva ciliaris, *Huds.*
Ceramium aciculare, *Roth.*
violaceum, *Roth.*
fruticulosum, *Roth.*
scoparium, *Roth.*

ART. XII.—*On a New Plan of Tunnelling, being calculated for opening a Roadway under the Thames.* *By* M. J. BRUNEL, Esq. F. R. S. Civil Engineer. With a Plate.

As the celebrated author of this plan has had the kindness to favour us with a description and drawings of his new method of tunnelling, which, though printed, are we believe not intended for separate publication, we conceive that our readers will be highly gratified by an explanation of a method which, in point of ingenuity and utility, has not been surpassed by any of our modern improvements in the useful arts.

The writer of this notice, had the peculiar gratification of examining, in 1818, in company with his much respected friend Professor Pictet, all the original drawings, on a large scale, at the house of Mr Brunel, and of having them explained by that distinguished engineer. Mr Brunel then mentioned that the idea upon which his new plan of tunnelling is founded, was suggested to him by the operations of the *Teredo*, a testaceous worm, covered with a cylindrical shell, which eats its way through the hardest wood; and has, on this account, been called by Linnæus *Calamitas Navium.* The same happy observation of the wisdom of Nature, led our celebrated countryman Mr Watt to deduce the construction of the *Flexible Water Main*, from the mechanism of the lobster's tail *.

"The difficulties," says Mr Brunel, "which have opposed themselves to every attempt that has been hitherto made to execute a tunnel under the bed of a river, have been so many and so formidable, as to have prevented its successful termination in those instances where the attempts have been made.

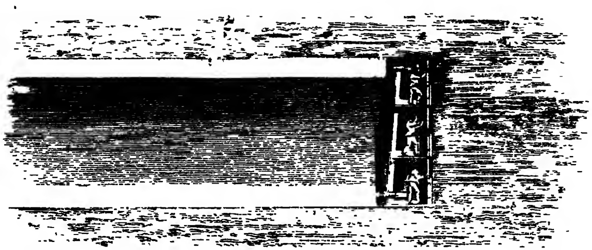
To propose, therefore, the formation of a tunnel after the abandonment of these several attempts, may appear somewhat presumptuous. On inquiring, however, into the causes of failure, it will be found that the chief difficulty to be overcome, lies in the inefficiency of the means hitherto employed for forming the excavation upon a large scale.

In the case of the drift-way made under the Thames at Rotherhithe in 1809, the water presented no obstacle for 930 feet;

* See this *Journal*, vol. iii. p. 60.

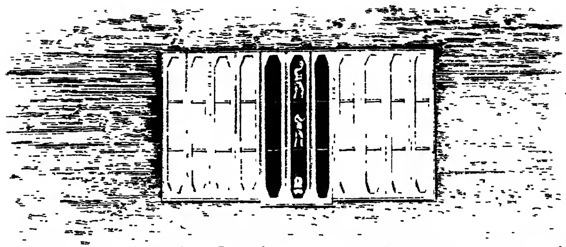
TUNNEL ACROSS THE RIVER THAMES

Fig. 1



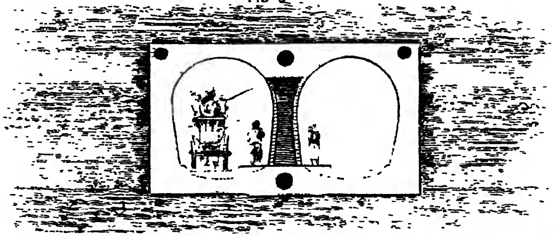
Longitudinal Section of the body of the Tunnel with the Framing preceding it

Fig. 2



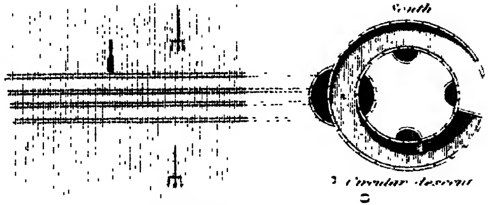
Elevation of the Framing shewing the Cells in three of which the Workmen are represented in operation

Fig. 3



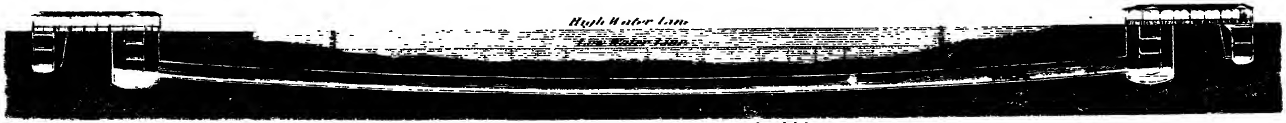
Transverse Section of the body of the Tunnel, shewing the double Archway

Fig. 4



Plan of the descent into the Tunnel

Fig. 5



Transversal Section of the River at Rotherhithe

Scale of Feet

and, when a great body of quicksand gave way, and filled the drift, the miners soon overcame this obstruction, and were able to proceed until they were stopped by a second irruption, which, in a few minutes, filled it. Nothing comes more satisfactorily in support of the system that is adopted here, than the result of the operations that were carried, under that circumstance, to an extent of 1011 feet, and within 130 feet from the opposite shore.

It is to be remarked, that, at the second irruption, on examining the bed of the river, a hole was discovered 4 feet diameter, 9 feet deep, with the sides perpendicular,—a proof that the body of quicksand was not extensive; but what is most remarkable is, that this hole could be stopped merely by *throwing from above, clay partly in bags and other materials:* and, after pumping the water out under a head of 25 feet of loose ground, and 30 feet of water, the miners resumed the work, and proceeded a little further; but finding the hole at the first irruption increased, and the *filling* over the second very much sunk, the undertaking was abandoned.

The character of the plan before us, consists in the mode of effecting the excavation, by removing no more earth than is to be replaced by the body of the tunnel, retaining thereby the surrounding ground in its natural state of density and solidity.

In order so to effect an excavation 34 feet in breadth by 18 feet 6 inches in height, the author of this plan proposes to have the body of the tunnel preceded by a strong framing of corresponding dimensions, as represented in the accompanying drawings (Plate IX.), and in the model proposed to be submitted for inspection. The object of this framing is to support the ground, not only in front of the tunnel, but at the same time to protect the work of excavation in all directions. The body of the tunnel, which is to be constructed in brick, is intended to be fitted close to the ground (See Fig. 1–3.); and, in proportion as the framing is moved forward, so the brick-work is made to keep pace with it. But, as this framing could not be forced forward all in one body, on account of the friction of its external sides against its surrounding earth, it is composed of eleven perpendicular frames which admit of being moved singly and independently of each other, in proportion as the ground is worked away in front. These several frames

are provided with such mechanism as may be necessary to move them forward, as well as to secure them against the brick-work when they are stationary. It is to be observed, that six alternate frames are stationary, while the five intermediate ones are left free for the purpose of being moved forward when required; these, in their turn, are made stationary for relieving the six alternate ones, and so on.

In order that a sufficient number of hands may be employed together, and with perfect security, each perpendicular frame is divided into three small chambers, which may properly be denominated cells, (See Fig. 1–2). By this disposition, 33 men may be brought to operate together with mechanical uniformity, and quite independent of each other. These cells, which are open at the back, present in front, against the ground, a complete shield composed of small boards, which admit of being removed and replaced singly at pleasure.

It is in these cells that the work of excavation is carried on. There each individual is to operate on the surface opposed to him, as a workman would cut out a recess in a wall for the purpose of letting in a piece of framing; with this difference only, that, instead of working upon the whole surface, he takes out one of the small boards at a time, cuts the ground to the depth of a few inches, and replaces the board before he proceed to the next. When he has thus gained from 3 to 6 inches over the whole surface (an operation which it is expected may be made in all the cells nearly in the same time), the frames are moved forward, and so much of the brick-work added to the body of the tunnel. Thus entrenched and secure, 33 men may carry on an excavation which is 630 feet superficial area, in regular order and uniform quantities, with as much facility and safety as if one drift only of 19 feet square was to be opened by one man.

The drift carried under the Thames in 1809, which was about the size of these cells, and was excavated likewise by only one man, proceeded at the rate of from 4 to 10 feet per day. In the plan now proposed, it is not intended that the progress should exceed the rate of 3 feet per day, because the work should proceed with mechanical uniformity in all the points together.

With regard to the line of operation, if we examine the nature of the ground we have to go through, we observe under

the third stratum, which has been found to resist infiltrations, that the substrata, to the depth of 86 feet, are of a nature that present no obstacle to the progress of a tunnel; we are informed that no water was met there. It is therefore through these substrata that it is proposed to penetrate, and to carry the line that is to cross the deep and navigable part of the river, leaving over the crown of the tunnel a head of earth of from 12 to 17 feet in thickness, quite undisturbed, (See Fig. 5).

Admitting that, in descending to, or in ascending from, that line, we should come to a body of quicksand, such as that which was found within about 200 feet from the shore, it is then we should find in the combinations of the framing, before described, the means that are necessary for effecting, upon a large scale, what is practised, on a very small one, by miners when they meet with similar obstacles. Indeed, were it not for the means of security that are resorted to on many occasions, mines would inevitably be overwhelmed and lost.

Although we may encounter obstacles that may retard the daily progress of the work, it is with satisfaction we contemplate that every step we take tends to the performance and ultimate completion of the object; and, if we consider that the body of the tunnel must exceed the length of Waterloo Bridge, it must be admitted that, if, instead of 2 years, 3 were necessary to complete the undertaking, it would still prove to be the most economical plan practicable for opening a land communication across a navigable river."

In order to execute the tunnel beneath the Thames by the method described in the preceding paper, it is proposed to raise a capital of L. 160,000 by transferable shares of L. 100 each. The following are the heads of expence:

Preparatory expences,	L. 9000	0	0
Expences of the execution of the work, which will require two years,	24,000	0	0
Expence of materials,	87,000	0	0
Purchase of ground,	20,000	0	0
Unforeseen expences,	24,000	0	0
Total,	L. 166,000	0	0
Value of steam-engine, &c.	6000	0	0
	L. 160,000	0	

Art. XIII.—*Observations on the Effects of Heat and of Motion.* In a Letter to J. F. W. Herschel, Esq. F. R. S. Lond. and Edin. from M. Seguin. Communicated by Mr Herschel *.

Sir, Annonay, 12*th Sept.* 1822.

I have taken the liberty of submitting, through your means, to the learned Society of which you are Secretary, a new method of considering the effects of heat and of motion, which my granduncle M. Montgolfier, with whom I spent a great part of my youth, had often discussed with me.

The principle which he maintained was, that the *vis viva* could neither be created nor annihilated, and consequently, that the quantity of motion on the earth had a real and finite existence.

In order to obtain an explanation of this result, I have observed, that, as all known bodies are elastic, and susceptible of experiencing variations of volume, the limits of which are unknown, their molecules must necessarily be at a distance from each other.

As even the most solid and dense bodies are capable of being evaporated,—a property which is indicated by their smell, we may conclude, that there escapes from them at each instant an infinity of molecules, which, from their tenuity, elude all the means of comparison which we can employ.

In order to assign to them the condition either of a solid, a liquid, or a gas, it is necessary to suppose the existence, and the combination of two forces, which are sometimes *in equilibrio*, and sometimes predominate the one over the other. We shall admit, then, the supposition, that these two forces may be the same as those which regulate our planetary system, and that the molecules of bodies are subject to circulate round one another, so

* This ingenious paper was communicated by its author to J. F. W. Herschel, Esq. as Secretary to the Astronomical Society of London; but being on a subject not Astronomical, Mr Herschel was so kind as to transmit it to Dr Brewster, for insertion in this Journal.

that each body, though it appears at rest, has really a certain quantity of motion, whose measure will be a function of the mass, and the velocity of the molecules in motion.

Upon these suppositions, it is obvious, that, during the impact of two bodies, all the quantity of motion which is not employed in giving the body which is struck a motion of translation, will go to augment the quantity of interior motion which it possesses; and if this motion takes place in circles or ellipses, the parts will recede from the centre of attraction, and the body will increase in volume. In this state it will have a tendency to transmit the excess of motion which it possesses, to bodies which are near it, or to parts which it will emit in greater number, in following the same law.

If the quantity of motion is so great, that the attraction of the molecules can no longer be *in equilibrio* with their angular velocities, the body will remain in the gaseous state, till it has transmitted to other bodies the excess of velocity which it possesses.

The particles, in continuing to circulate at a distance, or in detaching themselves from bodies with different velocities, may make different impressions upon organised bodies, viz. that of light, if the velocity is sufficiently great to make it traverse the humours of the eye; that of heat or flame, if their number is sufficiently great to put in motion or evaporate the organised parts, and that of both heat and flame, in the two cases united.

Bodies, in short, being subject to circulate in circles or in ellipses, ought to group themselves together, according to the simplest law of solids, inscribed in these two figures.

It is not difficult to observe the connexion which this theory has with magnetic phenomena, as well as the objections which may be made to it; but I shall forbear entering into more ample details, lest I should abuse the patience of the Society, if it should deign to notice an inquiry, which has for twenty years been the subject of my reflexions, assisted by those of the disciples of M. Montgolfier, who, like me, have had the advantage of living near him. I shall now conclude, by pointing out the application of this new theory to four facts, selected from the crowd of those which it may serve to explain.

The first is the quantity of motion which is suddenly developed by a glass tear (Prince Rupert's Drops), which has been dropped red-hot into water, when the slightest derangement has taken place in some of its parts.

The second relates to the effect of the steam-engine; for, if we consider the cause of it to be the caloric, it is not easy to see why we could not produce an indefinite number of oscillations with the quantity of caloric necessary to produce the first, if we could by any means whatever employ the low temperatures which are lost, to renew the effect. Whilst, if, as we suppose, an angular motion has been changed into a rectilineal motion, or into a motion of translation, we should find, after the effect, only the quantity of motion, or the caloric, which has not been employed in producing the useful effect.

The third fact consists in giving a satisfactory explanation of the great cold which exists in the higher regions of our atmosphere, whose temperature on the contrary, ought to be more elevated, by the quantity of caloric abandoned by condensed vapours, and the warmest gases, which tend upwards, by their extreme levity.

If we apply our theory to this case, we shall observe, that a gaseous body, on escaping at a tangent, in a direction contrary to that of its gravitation, is subject to the same laws as all other bodies in similar circumstances; and that, consequently, when it has arrived at the limit indicated by its initial velocity, it is found at rest, or, in other words, deprived of its caloric, and obliged to absorb a new quantity from surrounding bodies, in order to be reconstituted with the quantity necessary to determine its existence in any state whatever.

The fourth fact relates to the motion produced by organised bodies, and may be explained in the same manner as the steam-engine, which appears to me, in a great state of simplicity, to resemble, in a high degree, the vital functions, enjoying, like them, motion and heat, while it is furnished with oxygen and fuel.

If you consider these views, on a subject of vast extent, as meriting to be submitted to the distinguished members of your Society, I do not doubt, that, when viewed in the aspect in which I have been able to place them, they will not be able to

draw great advantages from them to science. The desire of putting them in contact with the great man who first conceived them, will plead my excuse for the liberty which I have taken in submitting them to your consideration. I am,

SIR,

Your very humble, and very obedient servant,

SEGUIN *Ainé.*

ART. XIV.—*Tables of the Variation of the Magnetic Needle in different parts of the Globe.* (Continued from p. 120.)

TABLE VIII. *Containing the Variation of the Needle, as observed in Asia and the adjacent Islands.*

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Alexandretta, Syria,	1694	14° 22′ W.
Aden, Arabia,	1612	13 40
	1612	12 40
	1674	15 0
	1723	13 50
	1723	13 42
Ava, India, -	1689	5 0
Aleppo, Syria, -	1781	12 30
Alguarda, near Goa,	1722	5 49
Anjunga, India,	1724	4 17
Bab-el-Mandeb,	1723	14 20
	1723	14 8
Baixos de Chagos Island,	1610	19 50
Beit-el-Fakih, -	1762	11 50
Bachian Island, Amasane Bay,	1612	4 48 E.
Bombay, India,	1676	12 0 W.
	1721	5 12
	1721	5 16
	1722	5 7
	1723	5 10
Banca Island,	1791	0 0
Balasore, India,	1680	8 20
Do. Cape Palmiras,	1722	3 33
Calicut, -	1722	4 5
	1772	4 9
Canton, -	1690	2 25
	1722	1 30
Carwar Bay, India,	1722	5 40
	1722	5 4
	1723	5 8
	1724	5 32

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Celebes, Bonthain,	1767	1° 16′ W.
Chaul, India,	1721	5 27
Cape Comorin, India,	1601	16 0
	1612	14 0
	1612	14 30
	1620	14 20
	1680	8 45
	1688	7 30
	1723	2 51
	—	2 48
	—	2 50
	—	3 9
Ceylon,		
Friar's Hood,	1722	2 12
	1722	2 21
Point de Galle,	1613	13 24
	1723	2 46
	1723	2 45
Chandernagore, India,	1731	3 0
	1735	2 0
	1743	1 20
	1745	1 0
	1747	0 0
	1750	0 [illegible]
Cochin, India,	1614	15 0
	1706	6 20
	1722	3 34
	1722	3 53
	1724	3 26
	1724	4 16
Daman, India,	1612	16 30
Dabul, India,	1610	15 34
	1611	16 30

Tab. VIII.—*Continued.*

Names of Places.	Year of Observation.	Magnetic Variation.
Derbent, Persia,	1712	12° 0′ W.
Darsina, Arabia,	1612	15 2
Doy or Doa, Molucca Islands,	1613	5 20 E.
Firando, an island near Japan,	1613	2 50
Goa, India,	1609	16 0 W.
	1706	6 40
	1722	4 57
	1723	5 13
	1723	5 3
	1724	5 41
Guadal Cape, Persia,	1613	17 15
	1616	18 0
Hainan Isl. China,	1613	0 50
Hyderabad *, 27th June,	1804	1 16.39 E.
Java, Bantam,	1609	3 0 W.
Java, Batavia,	1767	1 25
	1768	0 25
Java, Palimbang,	1605	3 20
Ispahan, Persia,	1787	7 30
Iriseh, -	1797	8 14
Ingana Island,	1607	4 13
Jask Cape, Persia,	1616	19 20
Judda, Arabia,	1769	11 52
	1776	12 55
Kasbin, Persia,	1787	7 33
Kerguelen's Land,	1776	27 44
Louveau, Siam,	1685	4 45
	1685	0 30 ?
	1686	4 45
	1688	4 30
Lucepara Island,	1767	0 0
Macao, -	1616	1 30
	1685	4 0 ?
	1779	0 32
Madras, India,	1722	2 52
	1723	3 16
Madura Island, near Java,	1768	0 30
Mangalore, India,	1722	5 24
	1722	5 35
	1723	5 5
Masulipatam, Ind.	1610	12 22
Machian Island, near Gilolo,	1612	4 12 E.
	1613	3 28
Maldevische Canal, -	1605	17 0 W.
	1722	4 16
Mazeira Isl. Arabia,	1613	20° 10′ W.
Mocha, Arabia,	1723	13 34
	1769	12 33
	1776	11 20
Mindanao, Cape St Augustin,	1767	1 45 E.
Nankin, China,	1685	0 0 W.
Nicobar, India,	1605	7 5
Paliacate, India,	1611	13 15
	1613	13 10
Patapilli, India,	1611	12 47
	1611	12 22
	1613	13 50
Pondicherry,	1689	7 0
Princes Island, near Java,	1767	1 0
	1780	0 54
Pulo Condore, Isl.	1620	1 0
	1780	0 14
Pekin, -	1755	2 0
St Paul's Island,	1677	23 30
Roquepiz Island,	1610	23 30
Rogipore (Rajapur),	1722	4 58
Rasalgat Cape, Arab.	1613	19 20
Sually, -	1610	16 40
	1611	16 30
	1612	17 0
Sunda Strait,	1615	3 30
Sinde, -	1613	16 45
Sinope, -	1797	10 18
Surat, -	1611	16 23
	1612	16 50
	1722	5 50
	1723	5 59
	1723	5 22
Singanfu, China,	1689	3 17
Sumatra, Achen, -	1610	6 25
Sumatra, Marlborough Fort,	1794	1 10 E.
	1795	1 8
Sumatra, Priaman,	1612	4 10 W.
	1613	4 50
Tellicherry, Ind.	1722	4 21
	1722	4 4
Tiiz, -	1613	18 30
Tecu Island, -	1612	4 40 E.
Xin-Yam, China,	1682	0 0 W.
Ula, China, -	1682	1 40 E.

* This is the mean of two observations made at the Camp near Hussain Sangor, by Lieut.-Col. Morison, and communicated to me by John Robison, Esq.—D. B.

TABLE IX. *Containing the Variation of the Needle, as observed in Africa and the adjacent Islands.*

Names of Places.	Year of Observation.	Magnetic Variation.
Alexandria, Egypt,	1638	5° 45′ W.
	1761	11 4
	1798	13 6
Ascension Island,	1678	1 0 E.
	1754	8 6 W.
	1768	9 53
	1775	10 52
	1806	15 40
Accara, Fort Guinea,	1726	11 25
	1726	11 53
Angoxa, -	1611	12 1
Ab-dal-Curia Isl. west of Sowtora,	1612	17 23
	1723	12 43
Algiers, Barbary,	1731	14 0
Azores Islands,		
Fayal Bay,	1589	3 5 E.
	1775	22 7 W.
Flores, -	1600	0 0
Marie, -	1610	1 40 E.
Bab-el-Mandeb,	1723	14 20 W.
	1723	14 8
Baxos de Chagos,	1610	19 50
Bourbon Isle of,		
Mascarenhas,	1614	22 48
St Paul's Bay,	1722	19 49
	1722	19 44
Boobam, -	1616	13 12
Cape Coast, -	1726	11 55
	1726	12 10
	1726	11 46
Canary Islands,		
Ferro, -	1724	5 0
	1769	17 30
	1802	19 55
Lanzarote,	1610	6 6 E.
Madeira, Funchal,	1727	6 58 W.
	1766	14 10
	1766	16 0
	1771	18 0
	1783	18 22
	1802	20 21
Grand Canary,	1610	6 6 E.
Teneriffe, Sta Cruz,	1769	15 43 W.
	1770	15 30
	1776	14 41
	1776	15 55
	1785	15 52
	1788	20 1
	1792	16 32
	1803	16 1
Comora Islands,		
Angoxa, on coast of Africa,	1611	13° 0′ W.
	1721	19 12
	1721	19 44
	1721	20 33
Anjouan,	1722	20 39
	1722	20 33
Mayotta,	1722	21 12
	1722	20 24
Molalio,	1611	15 20
Cape Verd Islands,		
Porto Praya, St Jago,	1725	4 5
	1766	8 20
	1766	8 20
	1772	10 45
	1791	14 12
Mayo, -	1725	3 32
	1776	9 32½
Sal, -	1610	8 30 E.
Cairo, -	1694	12 15 W.
	1761	12 25
	1762	11 40
	1798	12 0
Damietta, Egypt,	1694	12 30
Doara, Ajan,	1611	17 36
	1611	17 20
Prince Edward's Island, -	1776	26 15
France, Isle of, (Mauritius)	1609	21 0
	1722	18 46
	—	18 39
	—	19 7
	—	19 45
Cape of Good Hope,		
Cape l Agulias,	1609	0 12
Saldanha Bay,	1605	0 30 E.
	1614	1 30 W.
Simon's Bay,	1780	22 16
	1791	23 40
Table Bay,	1614	1 45
	1667	7 15
	1675	8 28
	1687	8 30
	1699	11 0
	1702	12 50
	1706	13 40
	1708	14 0
	1721	16 25
	1724	16 27

TAB. IX.—*Continued.*

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Cape of Good Hope,		
Table Bay,	1724	16° 18′ W.
	1752	19 0
	1768	19 30
	1772	20 26
	1775	21 14
	1788	23 16
	1792	24 30
	1804	25 4
Gorée, -	1682	0 0
	1769	12 15
	1772	10 30
Guardafui, Cape,	1610	17 35
	1612	17 34
	1721	11 11
	1723	12 34
Hermanas Island, near C. Guardafui,	1610	18 55
	1612	17 23
St Helena, Island of, -	1600	8 0 E.
	1604	7 45
	1610	7 13
	1623	6 0
	1677	0 40
	1691	1 0 W.
	1724	7 30
	1764	11 38
	1768	12 47
	1775	14 18
	1785	12 18
	1789	15 30
	1796	15 48¼
	1808	17 18
Madagascar,		
Augustin's Bay,	1607	15 39
	1607	15 26
	1610	14 50
	1611	15 11
	1613	15 40
	1721	23 46

NAMES OF PLACES.	Year of Observation.	Magnetic Variation.
Madagascar,		
Antongill Bay,	1661	22° 30′ W.
	1761	18 0
Fort Dauphin, -	1661	19 0
	1761	22 7½
Foul Point,	1762	16 45
St Sebastian, Cape,	1600	16 0
	1610	16 40
	1722	19 1
	1722	18 36
St Mary's Island, near Madagascar,	1610	19 50
	1722	19 53
	—	19 55
	—	19 25
Nosf-Gombi, an island near Madagascar,	—	20 0
	—	19 45
	—	19 5
Salée Roads, -	1735	12 19
Sierra Leone,	1608	1 50 E.
	1725	5 12 W.
Sunken Rocks, S. Lat. 31° 48′,	1606	21 0
Socotra, Island of,	1611	16 0
	1612	17 22
	1674	17 0
	1723	11 25
	—	11 36
	—	11 39
	—	12 4
	—	11 57
	—	12 20
	1776	8 6
St Thomas, Isle of,	1726	14 48
	1726	14 32
Tripoli, -	1733	13 22
Trinidad, Island S. Lat. 20° 45′ N. Long 29° 30′,	1615	12 0 E.

ART. XV.—*On the Forms of Crystallisation of Sulphato-tri-Carbonate of Lead.* By W. HAIDINGER, Esq. F. R. S. E. *

COUNT BOURNON seems to have been the first author who erected the lamellar varieties of lead-ore from Leadhills into a separate species, under the name of *Plomb Carbonaté*

* This paper is a brief abstract of the original memoir read before the Royal Society of Edinburgh, on the 16th February 1824. The crystallographic develop-

Rhomboidal, which he describes * as presenting the form of a regular six-sided prism, or also that of an acute rhombohedron of 70° 32′ (the plane angles being given = 60° and 120°), diversely modified by planes perpendicular and parallel to its axis. He considers the acute rhombohedron as the primitive form of the species. Mr Brooke †, who calls this substance *Sulphato-tri-Carbonate of Lead*, likewise states the form of the crystals most commonly occurring to be a regular six-sided prism, or an acute rhombohedron of 72° 30′, terminated by a plane perpendicular to its axis; the latter being parallel to the perfect planes of cleavage. He mentions, besides, a considerable number of secondary faces, and he has given the drawing of a variety, which contains them, in the third edition of Phillips' Mineralogy, page 342., where he likewise assumes the acute rhombohedron as the primary form of the mineral. Supposing the angles given by Mr Brooke to be exact, Professor Mohs also considered it as rhombohedral, and arranged it in the genus Lead-baryte, under the denomination of the *Axotomous Lead-baryte*, being most distinctly cleavable in a single direction intersecting the principal axis. Contrary to the general observation, that rhombohedral substances possess only one axis of double refraction, Dr Brewster ‡ found that the mineral in question exhibited two axes or two systems of coloured rings, more distant from each other than those of carbonate of lead; and from the existence of the two axes, he inferred that its forms belonged to the prismatic system. He also remarked, that many crystals contain films oppositely crystallised, as is the case in Arragonite.

I had at various times attempted to examine the forms of axotomous lead-baryte, without, however, attaining a sufficiently correct result; but having lately resumed this examination, the beautiful specimens in Mr Allan's collection, and several

ment of several of the varieties will be found in *The Edinburgh Transactions*, vol. X. part 1.

* *Catalogue de la Collection Minéralogique*, p. 349.

† *Edinburgh Philosophical Journal*, vol. iii. p. 118.

‡ *Edinburgh Philosophical Journal*, vols. iii. p. 138.; vi. p. 183.; ix. p. 367.

others, equally interesting, with which I had been favoured by Dr Brewster, Mr Irving, and Mr T. Dowler, have enabled me to ascertain the forms of this species with a considerable degree of accuracy. The results of that examination are very remarkable. They exclude the rhombohedron and the regular six-sided prism from the range of forms, which the individuals of the species may assume, and thus perfectly confirm the inference drawn by Dr Brewster from his optical observations, while they are at variance with the crystallographic statements both of Count Bournon and of Mr Brooke.

By means of the reflective goniometer, I found that the six-sided prisms are not regular, but that they are combinations of three different simple forms, *a*, *b*, and *c*, Plate X. Fig. 1.; the inclination of *a* upon *b* being = 90° 29′; that of *c* upon *c* = 120° 20′; and that of *b* upon *c* = 119° 50′. Though slight, these differences are easily ascertained, and their consequences, in the disposition of the crystalline faces, are so obvious, that they would certainly not have escaped the practised eye of the crystallographers who described them, had not a particular mode of regular composition seemed to establish a kind of symmetry round a rhombohedral axis supposed to be perpendicular to the faces of cleavage.

The system of crystallisation to which the forms of Axotomous Lead-baryte belong, is not, therefore, the rhombohedral system, nor do these forms enter into that class of prismatic forms which exhibit the full number of faces of every simple form in the combinations, but they must be considered as hemi-prismatic, the axis of crystallisation, which is parallel to the edges of the prism *c*, being inclined to the base at an angle of 90° 29′.

There are two observations which can be very easily instituted on almost every group of well-pronounced crystals of the species, and which evidently prove that the forms of these are really hemiprismatic. The first of them refers to *oblique* truncations of the lateral edges, between *b* and *c*, as *d*, *d*, in Fig. 2., which are inclined to *b* at an angle of 156° 27′, and to *c* at an angle of 143° 28′. The other refers to the slightly, but very distinctly, marked planes of conjunction, between two individuals in the regular compositions, in a direction joining alterna-

ting angles, like A and B, Fig. 1., in the supposed regular six-sided prism. The remainder, ABA′, of the terminal face of one of the individuals, is inclined to the similarly situated face of the other at an angle of 179° 10′, to which, on the opposite side, corresponds a re-entering angle of 180° 50′. Both these facts I had observed separately in numerous specimens, but the smallness of well-pronounced crystals, and the impossibility of distinguishing by the eye an angle of 119° 50′, from one of 120° 20′, rendered it very difficult to combine these observations into one representation of its forms. The observation, that the plane of the resultant optical axes passes through a line parallel to A′A, Fig. 1., led me to inquire whether the face *b*, which I had before supposed to be one of the faces of an oblique-angular four-sided prism, might not be parallel to the short diagonal of the prism produced by the enlargement of the faces *c*, *c*, &c. The examination of a small, but beautiful, and very regularly formed twin-crystal, in the collection of Mr Allan, carried on upon this supposition, gave at last the results which form the substance of this paper. One of the individuals of that regular composition is represented in Fig. 2.; and Fig. 3. is its projection, on a plane parallel to the face *a*, the whole of the crystal having been duly completed.

If enlarged to their mutual intersection, P and P′ produce the fundamental form of the species, a scalene four-sided pyramid, in which the axis of the form, is inclined to a line perpendicular to the base, at an angle of 0° 29′. In the method of Professor Mohs this angle is called the *Inclination of the Axis*, and the variable quantities considered are, the line perpendicular to the base of the pyramid, which line is called *a*, the diagonal *b*, in the plane of inclination, the other diagonal *c*, and a fourth line *d*, which corresponds to, or subtends, the angle of inclination.

The ratio of these lines $a : b : c : d$, which gives a result agreeing nearest with observation, is that of $120 : 95 : 54.5 : 1$. Upon this supposition the angles of the fundamental form are the following: Inclination of P upon P over the face $f = 72° 36'$; of P′ upon P′, on the opposite side, $= 72° 10'$; of P upon P′ contiguous to the same apex, $= 124° 50'$; of P upon P′, contiguous to the opposite apex, $= 137° 0'$.

The following table contains some of the most important angles, together with the crystallographic signs, referring to the simple forms, according to the method of Professor Mohs.

Inclination of $P-\infty$ (*a*) upon	Angle at the edge contiguous to the plane of inclination in
$\frac{P\breve{r}-1}{2}$ (*i*) = 147° 52′	$P\bar{r}-2$ (*l*) = 122° 20′
$\frac{P\breve{r}}{2}$ (*f*) = 128° 40′	$P\bar{r}-1$ (*m*) = 84° 30′
$\frac{P\breve{r}+1}{2}$ (*e*) = 112° 0′	$\frac{3}{4}P\bar{r}$ (*n*) = 62° 24′
$P\breve{r}+\infty$ (*b*) = 90° 29′	$\frac{P-1}{2}$ (*g*) = 94° 18′
$-\frac{P\breve{r}+1}{2}$ (*e′*) = 111° 11′	$-\frac{P-1}{2}$ (*g′*) = 93° 52′
$\frac{P-1}{2}$ (*g*) = 128° 23′	$\frac{(\breve{P}-2)^4}{2}$ (*h*) = 142° 26′
$-\frac{P-1}{2}$ (*g′*) = 128° 5′	$\frac{(P\breve{r}-1)^3}{2}$ (*k*) = 111° 32′
$\frac{P}{2}$ (*P*) = 111° 42′	$(\breve{P}+\infty)^4$ (*d*) = 132° 54′
$-\frac{P}{2}$ (*P′*) = 111° 18′	$P+\infty$ (*c*) = 59° 40′.
$P+\infty$ (*c*) = 90° 14′	

The perfectly hemiprismatic appearance of a crystal similar to the given figures, would be alone sufficient for excluding the forms of axotomous lead-baryte from the rhombohedral system, even though the measures of the angles should have been found to approach still nearer to 120° and 90°. But one and the same individual seldom presents more than one or two of its six sides to the observer, being in most cases joined to other individuals, according to the law of regular composition mentioned in the beginning of this paper.

The planes of composition pass through a line nearly perpendicular to two sides of the six-sided tabular crystals, like AB,

Fig. 4. They are parallel to one face of $(\breve{P}+\infty)^3$, $= 119° 40'$, a prism which is likewise found in the crystals of this species. Upon this supposition, the angles are $= 90° 20'$, and $89° 40'$. Of the individuals AA'BCDE, and AA''BC'D'E', which meet in the plane of composition passing through A B, nothing will remain but the rhomb-like trapezium AA'BA'', the angles of which are $A = 60° 20'$; A' and A'' each $= 119° 50'$, and $B = 60°$. If a third individual A'A''CGFC' joins the regular composition of the preceding two, being applied to BMA', the remainder of BAA', Fig. 4. in the line A'M, there will also arise a face of composition between A'MA'' and BMA', and the angles of the remaining triangular figure A'A''B, Fig. 5. will be exactly $= 60°$. In the compound crystals of axotomous lead-baryte, each of the edges A'M, A''M, and RM is $= 179° 10'$.

The regular composition of three individuals, if the faces of $P\breve{r} + 1$ or e are considerably increased, while those of $\frac{P}{2}$ or P disappear, assumes very nearly the form of an acute rombohedron, whose apices and lateral solid angles are truncated, as in Fig. 6. The incidence of e upon e' is $= 72° 39'$, almost the same as the angle given by Mr Brooke for the terminal edge of his acute rhombohedron. Even in crystals most perfectly formed, it is very easy to overlook the small salient angle of $179° 10'$ upon the faces RST, supposed perpendicular to the axis of the rhombohedron; but this composition is often so intricate, particularly in larger crystals, that it sometimes becomes difficult to point out the direction and extent of each separate individual, though the existence of the composition is indicated by small, salient and re-entering angles, and proves, with the highest degree of evidence, that the forms of axotomous lead-baryte are not Rhombohedral but Hemiprismatic.

Although the observation of the optical properties of minerals can never supersede the study of their regular forms, yet the preceding examination of the forms of axotomous lead-baryte, affords an ample proof that they may be highly useful in guiding us through the latter, particularly if these regular forms nearly coincide with certain limits. The crystallographic researches relative to this species are attended with considerable difficulties,

since the angles approach in every instance within one degree to the limits of 120° and 90°, and the regular composition very often hinders the crystals from being observed on all sides, while the inclination of the optical axes of no polarisation upon each other is very considerable, and easily ascertained.

The inferences drawn from Dr Brewster's general law, respecting the existence of two polarising axes in crystallised substances, had excluded the forms of axotomous lead-baryte from the rhombohedral system, previous to their correct determination, and even in contradiction to the opinions entertained by crystallographers. The preceding demonstration, that they are hemiprismatic, reconciles the results of both sciences.

Art. XVI.—*Notice respecting the genus Caligus of Leach.* By George Johnston, M. D., Extraordinary Member of the Royal Medical, and Corresponding Member of the Medico-Chirurgical Societies of Edinburgh.

SIR,

I AM not aware that any naturalist has heretofore suspected, that there exists a considerable difference in the external structure of the sexes, of at least one species of the curious genus Caligus. My observations have led me, however, to believe, that this is the case; and should they appear to you as new as they are to me, this notice may, perhaps, be deemed not unworthy a place in the *Edinburgh Philosophical Journal.*

In the autumn of 1822 I found, on the common cod-fish, what I considered at the time a non-descript species of Caligus. A few weeks since, I met with the same animal, but intermixed on the body of the fish, with the *Caligus Mulleri* of Leach; and on a comparative examination, their resemblance in general form, and more particularly in the form of the clypeus, antennæ, and legs, was so close as to suggest, that they might be but the male and female of the same species. I felt more confirmed in the accuracy of this conjecture, on finding in the only three perfect specimens of the *C. Mulleri* I had procured, two little packets of eggs attached beneath to the lower end of the large segment of

the abdomen, which none of the others, and of them I had a considerable number, possessed.

Fig. 12. Pl. VII. is an outline of what I consider as the female, considerably magnified, and Fig. 13. represents the male. Between all the parts of the thorax, in both there is a strict agreement, with the exception of the fourth pair of legs, (*uncinuli?* Müller,) which in the male are very large, in proportion to the others, strongly toothed on the inner margin, and armed with a stout claw; while in the female these legs are small, and without teeth. The pectinated membranaceous laminæ affixed to the inferior angle of the clypeus, are also somewhat larger in the former than in the latter. But the chief difference is in the abdomen. In the female, it consists of three very disproportionate segments, which, however, are not separated by any distinct lines from one another. The first is very small. The second is large, narrowed above and truncate behind, where, on each side, is attached a cylindrical jointed process, (*filamenta ovipara* of Müller), in length exceeding the whole body. The third segment might, aptly enough, be termed the *caudal.* It is a very small process, projecting between the filaments, terminated behind by two papillæ, which again have on their extreme points three short transparent setæ. In the male there are no *filamenta ovipara.* The abdomen is smaller in proportion to the thorax, and its segments are more distinctly marked. The first is small, angulated, and bears the seventh pair of legs, which are in every thing similar to those of the female; the second is broader, considerably larger, rounded before, truncate behind, with two small spines at each external angle; the third segment is considerably less than the second, cordate, terminated behind by two papillæ, whence, as it were, issue from each, three acuminated spines, (of which the mid-one is the longest), finely ciliated an each side, and in length nearly equalling that of the abdomen, (Fig. 14.) These particulars are well enough expressed in the figures, which will give a more correct idea of them, than any description can convey, though they are neither so accurate nor so finished as I could have wished.

Should these observations be verified, they will necessarily introduce a material alteration not only into the specific, but generic characters. These, however, can be formed by him only

who has examined the whole group, which I have had no opportunity of doing. I may be permitted just to remark, that the character "*antennæ setaceæ,*" admitted into the definition of the genus by Müller, Latreille, and Lamarck, seems to me altogether inapplicable to the species before us. The antennæ are situate at the extremities of the anterior portion of the clypeus, which bears the eyes, and which might properly be termed the *frontlet.* They are very short, round, somewhat thickened outwards, and their parts furnished with two (Dr Leach says one) unequal setæ, and a few very minute hairs. The margins of the clypeus are not ciliated, as Müller says those of his *C. curtus* are, but surrounded completely by a very delicate transparent membrane. The *celliform bodies* on the dorsum of the clypeus, whatever opinion may be formed concerning their nature or use, afford surely a character of too great importance to be overlooked; and yet they are omitted by all the authors above cited, and even in the figures of Leach. Nor have the membranaceous lamellæ, fringed by large pectenated setæ, similar to those of the six pair of legs, (see Leach's figure), and placed beneath at the inferior angle of the clypeus, been observed by any but by Dr Leach, who, however, says there is one only, while in all our specimens, male and female, there are two on each side. It is not a little singular, too, that neither Muller nor Leach should have met with specimens bearing ovaries. Risso had observed them on the *C. productus;* but, as far as I know, none but myself has seen them in any other species. Müller believed that the eggs were produced in the jointed processes, and hence named them "*filamenta ovipara;*" and though this opinion is now proved incorrect, yet, since they are peculiar to the female, one cannot but conjecture that their function has some relation to the production or aerifaction of them. Dr Leach's figures of the legs in the *Supp. Encycl. Brit.* Pl. xx., are very accurate. I am, Sir, your most obedient servant,

George Johnston.

ART. XVII.—*Account of part of a Journey through the Himalaya Mountains*. By Messrs A. and P. GERARD *. Communicated by Colonel GERARD.

FROM Soobathoo, in Lat. 30° 58′, and Long. 77° 2′, situated about 20 miles from the plains, and 4200 feet above the level of the sea, I marched to Numbeg, 9 miles. 3½ miles from Soobathoo I crossed the Gumbur, an inconsiderable stream, but it had swollen so much from late rains, that its passage was effected with great difficulty. The road was a descent to the Gumbur, from which it slightly ascended.

22d September.—Marched to Semta, 13 miles. The road for the first 8¼ miles was almost plain, then there was a steep ascent of 1½ miles, and the last 3 were excellent, winding near the top of a range 7000 feet high, and lying through a noble wood of many varieties of oak and pine.

23d September.—Marched to Bunee, 11 miles. The road was plain, leading amongst deep forests of pine, at the height of 8000 and 9000 feet above the sea. Thus far the path, which is practicable upon horseback, has been made by a company of pioneers, for the facility of communication with the cantonment of Katgoor, 34 miles farther to the NE.

24th September.—Marched to Pulana, 10 miles. Left the made road 6 miles from last camp, and descended by an indifferent footpath to the village which belongs to the Rana of Theog.

25th September.—Marched to Kotkhaee, 11 miles. The road lay along the banks of the Giree, one of the branches of the Jumna, and was often rocky and dangerous, the footpath being frequently overgrown with grass, and seldom half a foot in breadth.

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* This curious and interesting article, was read at the Royal Society of Edinburgh, on the 17th February 1824. The Barometrical and Trigonometrical Observations which it contains may be considered as removing all doubt respecting the heights of the Himalaya Mountains.—*D. B.*

Kotkhaee is the residence of the Kotgoon Rana, a hill chief, under the protection of the British Government. It is situated on a most romantic spot, on a point below which two streams unite to form the Giree: on one side, the rock is 182 feet perpendicular, and on the other there is a long flight of stone steps; neither of the streams, which are only 20 feet broad, are fordable, so that, by destroying the bridges, the place might be well defended against musketry. The Rana's residence is 3 storeys high, and has a most imposing appearance; each storey projects beyond the one beneath it, and the top is crowned by a couple of handsome chinese turrets, beautifully adorned with finely carved wooden work.

26th September.—Marched to Gujyndee, 8 miles. The road at first lay up the rocky bed of one of the branches of the Giree, and then came a very steep and tiresome ascent to Dervisee Pass, from whence there was a descent to camp. Gujyndee is in Nawar, a small district of Buschur, famed for its numerous iron mines; there are few spots here fit for cultivating, and the inhabitants, who are all miners, live by their trade in iron. They work the mines only about three months in the year; and commence digging them in March, after the snow has sufficiently melted; at other times they say the earth falls in, and it is unsafe to work.

27th September.—Proceeded to Rooroo, a fatiguing march of 18 miles, crossing a high range of mountains. Here we first came upon the Pubur, one of the feeders of the Icus, which falls into the Jumna, and a stream of considerable size. Barometrical observations gave the extreme height of its bed 5100 feet.

Rooroo is situated in Choara, one of the large divisions of Buschur, and the most populous and best cultivated spot I have seen in the hills: the dell is broad, and the ground is well adapted for rice fields, being watered by many cuts from the river, which winds through it. Two marches more, or 26 miles, brought me to Jangleeg, the last and highest village in the valley of the Pubur, elevated 9200 feet above the sea. The road latterly was extremely rugged and dangerous; at one time many hundred feet above the river, with a horrid precipice on the right, and, at another, dipping down to the stream, which rushes with

violence over the rocks interspersed in its channel. As you advance, the dell in which the Pubur flows becomes gradually more contracted, the mountains assume a more naked and abrupt appearance, and the rapidity and turbulence of the river increase.

From Jangleeg I proceeded 10 miles to a halting place, called Moondar, within 2 miles of the Brooang Pass over the great snowy range: the road was good, and lay in a broad grassy glen, between two spurs of the Himalayas, with the Pubur running through it. The soil of this valley is composed of black vegetable mould, which produces endless varieties of alpine plants to the height of 13,000 feet. Belts of birch and pine reach almost the same elevation; beyond which scarcely any thing is seen but patches of brown grass.

The height of my camp, which was pitched beneath an immense projecting granite rock, was 12,800 feet. We left the last cluster of birch trees 3 miles behind us, so that we had to send back all that distance for firewood. The thermometer was 38° at night, and water froze hard.

Next day, 2d October.—We pitched our tent on the crest of the pass, 15,095 feet above the level of the sea. The road was of the worst description, crossing the Pubur, which has its source near this, by an arch of snow of some extent, and then leading over huge detached masses of granite hurled from the peaks above, and piled upon one another in dreadful confusion, with here and there some snow. The ascent was steep the whole way, and almost the only vegetation we noticed was grass in small tufts, which grew more scanty as we advanced to the pass, where it almost disappeared: It was still seen above, thinly scattered and intermixed with a few mosses. Here I met my brother, who had left Soobathoo some time before me, and travelled by a much more circuitous route.

We sent most of our servants down about 5 miles to a more congenial climate, where wood could be procured. The peaks immediately on either side of us were not more than 1000 feet above us, but there are several not very far distant which we could not now see, 18,000 feet high. We were lucky in getting the altitudes and bearings of the principal mountains across the

Sutluj, which rear their white heads to the height of 20,000 feet and upwards.

The thermometer in a tent got up so high during the day as 50°, but at 4 p. m. it fell to the freezing point, and at 7 was 8° below it. We sat up till past 10, for the purpose of making astronomical observations, which was cold work, and amused ourselves in smoking dried tobacco, which we found far from unpleasant. Our situation was not the most agreeable, for we had but a small supply of firewood, which was kindled in the middle of the tent, and we were involved in a cloud of smoke, and surrounded by servants, whilst every now and then we were alarmed by the crash of rocks, split by the frost.

We had all severe headaches during the night, owing probably to the rarefaction of the air, but attributed by the natives to a poisonous plant, said to grow most abundantly at the greatest elevations.

This pass separates Choara from Koonawur, another of the grand divisions of the Buschur, which lies on both banks of the Sutluj, extending from Lat. 31° 30′ to 32°, and Long. 78° 10′ to 78° 45′. It is a secluded, rugged and barren country, seldom exceeding 8 miles in breadth. It is terminated on the N. and NW. by a lofty chain of mountains, covered with perpetual snow, upwards of 20,000 feet high, which separates it from Ludak: a similar range of the Himalayas, equal in height, bounds it to the southward: on the east, a pass almost 14,000 feet high divides it from the Chinese dominions; and on the west lies another of the principal divisions of Buschur.

The villages, which are elevated from 8000 to 12,000 feet above the sea, are very thinly scattered; not more than two or three occur in a stage, and sometimes none at all for several days. In the summer season, from the reverberation of the solar rays, the heat in the bed of the Sutluj, and other large streams, is oppressive, and quite sufficient to bring to maturity grapes of a delicious flavour, of which raisins, and a spiritous liquor called Rakh, are made.

The inhabitants wear a frock of white blanket, often twofold, reaching down to the knees, and having sleeves, a pair of trowsers, and girdle of the same, a cap of black blanket like a bonnet, and shoes, of which the upper part is woollen, and the sole

alone of leather. The people are very dark, and extremely dirty, but they seem to enjoy a much greater degree of comfort than any of the other mountaineers we saw. The villages are generally large, and the houses spacious, and even elegant. They are built of stone and wood, and either slated or flat roofed; the last is most common. The temples of the Deotas (deities) are magnificent, and adorned with a profusion of ornaments. There are two or three in almost every village; and the various feats ascribed to their gods surpass belief: there is scarcely one of them that has not got the credit of removing some mountain or large rock to make the road passable, &c.

The level spaces of land in Koonawur are few, the crops are extremely poor, and a want of grain pervades the whole country. In time of scarcity, pears, and horse-chesnuts, after being steeped in water to take away their bitterness, are dried, and ground into flour. There are, however, no marks of poverty, and the natives subsist by exchanging raisins and wool for grain. They have little to do, but look after their vineyards, and attend to their flocks, which in summer are sent to pasturage at some distance from the villages. Bears are very numerous, and commit great ravages. In the grape season, during the whole night several people from every village, together with their dogs, are employed in driving them off.

The dogs are of a large ferocious breed, covered with wool, and extremely averse to strangers, whom they often bite and tear in a most shocking manner. They are commonly chained during the day, otherwise it would be dangerous to approach a village.

The winter is rigorous, and for three months there is no moving out of the villages from the quantities of snow. During this season the inhabitants employ themselves in weaving blankets. They early begin to collect their winter-stock of fuel, and food for their cattle, which latter consists chiefly of the leaves of trees, and they pile it upon the tops of their houses. The Koonawur language, of which we made a collection of near 1000 words, differs much from the Hindoo, most of the substantives ending in *ing* and *ung*, and the verbs in *mig* and *nig*.

On the 3d October the thermometer was 15° below the freezing point, and the cold intolerable; we therefore waited till two

hours after sunrise, and then proceeded to the village of Brooang, distant $8\frac{1}{2}$ miles.

The road lay over a thick snow-bed for the first mile, and then led through extensive woods of various sorts of trees, amongst which we recognised the hazel, plane, horse-chesnut, &c. &c. It was often rugged and rocky, and there was a steep descent of 7600 feet perpendicular height. On our way down we found black currants and raspberries in the greatest perfection, of which we preserved a large quantity; and on our arrival at camp we feasted on grapes. Brooang is a small village in Tookpa, one of the divisions of Koonawur, under the Wureer Teekumdas. It is situated near the Buspa River, and about two miles from the left bank of the Sutluj.

4th October.—We marched to Pooaree, a distance of $12\frac{1}{4}$ miles; the road was extremely bad, lying often upon the face of a naked stone inclined to the horizon at a considerable angle, with a precipice of many hundred feet on the outer side. It was no great ascent or descent, but so much caution was necessary to prevent the traveller from slipping off the rocks into the River Sutluj, which lay close upon our left, that the journey took us up twelve hours. To-day we crossed the Buspa, a large stream, 42 feet broad, whose source is six marches to the SE. of Brooang.

5th October.—We proceeded to Rispe, a march of $13\frac{1}{2}$ miles, likewise occupying us the whole day. The road, which lay through thin forests of pine, was not so dangerous as yesterday's, but consisted of several steep ascents and descents, upon rocks of crumbling granite, of 2000 feet each. We had a grand view of the Kylas, or Ruldung Mountains, from the large town of Reedung, or Ribe, about $3\frac{1}{2}$ miles before we reached camp. Imagine to yourself an assemblage of pointed peaks, presenting a vast surface of snow, viewed under an angle of 27°, and at a distance of not more than 5 miles in a direct line. The height of our station was 8000 feet, and the Kylas peaks were 12,000 feet higher. At Rispe, we first saw Lamas; and near this place we passed several buildings, from 10 to 40 feet in length, 2 broad, and about 4 high. They are constructed of loose stones, without cement; and upon their tops are numerous pieces of slate, of all shapes and sizes, carved with strange characters:

they are called Mane, and are erected over the graves of the lamas. There are invariably roads on each side of them, and the natives, from some superstitious custom, always leave them on the right hand, and will rather go a round of a quarter of a mile than pass them on the wrong side.

6th October.—We marched to Murung, 5 miles. The road was pretty good along the left bank of the Sutluj, crossing a river named Teedoong, whose source is in the Chinese dominions, four days' journey to the eastward. Murung is a Lama town of considerable size, consisting of seven or eight distinct divisions, and beautifully situated, chiefly upon a southern exposure, in a glen, which forms the greater part of an ellipse. Through it runs a transparent stream, upon the banks of which are extensive vineyards and orchards, abundantly supplied with water by numerous cuts. The dell is encircled by lofty mountains, at an angle of 25° on every side, except to the westward, where it is open towards the Sutluj, on the banks of which is a small fort. The situation is extremely romantic, and the approach to it highly picturesque, leading along a small canal, and through an avenue of apricot-trees. Near this place there are a great many piles of stones, with inscriptions; and afterwards we met with them almost at every village until we reached Pangee, on our return, where they end. We also saw a number of temples, called Chosten, which are likewise to be found in the vicinity of every Lama habitation; they consist of an inclosure, formed of three walls, with a roof, and open in front. In the inside of these are one or more small white-washed buildings, shaped like urns.

It was our intention to have proceeded farther, but the people told us the next village was at such a distance, and the ascent so fatiguing, with no water on the way, that we could not possibly reach it that night.

7th October.—Marched to Nisung, 8 miles. The road commenced with a very tiresome ascent of 5300 feet: here we were delighted to find numerous beds of juniper, and some gooseberries, which were the first we had seen since we left Scotland; we were in great hopes we should have met with heather, but we saw none. At the top of Toongrung Pass, 13,739 feet high, it

began to snow, and the thermometer was below the freezing point, so that we were glad to make the best of our way down. The footpath was good, but a steep descent, through juniper and thyme of many kinds, to Nisung, a small Lama village, situated near the Taglakhar, a large stream, which rises in Chinese Tartary, three or four marches to the eastward. The extreme height of this village, by corresponding barometrical observations, is 10,165 feet, and grapes do not ripen here. We saw several gardens of fine large turnips, fenced round with hedges of gooseberries; the latter are of the red sort, small, and extremely acid, but make a capital tart.

8th October.—We were delayed till 2 P. M., in order to get grain ground for the consumption of our people, there being no village at the next stage. We only marched 1¾ miles, and the road at first was a descent to the Taglakhar, and then a steep ascent of 2000 feet, most part of the way up a slope of 40°, and over rugged rocks. We were obliged to halt here, there being no water for many miles a-head.

9th October.—Marched 10 miles to the bed of a mountain-torrent, and did not arrive till an hour after dark. This day's journey was one of the most tiresome we had experienced, crossing two mountains of 12,000 and 13,000 feet. The ascents and descents, one of which was full 4000 feet in perpendicular height, were steeper for a longer continuance than any we had yet seen, and the path was strewed with broken slate, which gave way under the feet. Neither tent nor eatables arrived, and we had nothing but cakes of very coarse meal, which, however, hunger made palatable. Upon this kind of food, together with a few partridges, which our sepoys occasionally shot, and without either plates, knives, or forks, we lived for five days. It would have been amusing to see us sitting upon blankets, near a fire, in the open air, surrounded by our servants, dissecting the partridges with the kookree, or short sword, worn by the Goorkhalees, and smoking plain tobacco out of a pipe little better than what is used by the lowest classes. Novelty, however, has its charms; and our being in a country untrodden by a European, gave us a delight amidst our most toilsome marches scarcely to be experienced, much less imagined, by a person who has never been in the same situation.

10*th October.*—Marched to Dabling, $6\frac{3}{4}$ miles. The road was pretty good, lying near the river. We went a little out of the direct way, to visit the Numptoo Sango, a wooden bridge across the Sutluj. The river was here 106 feet broad, and the bridge 78 feet above the stream, which rushes with rapid violence between perpendicular rocks of granite. We in vain tried to measure its depth: and though we had a heaving-lead for the purpose, of no less than ten pounds weight, we could not effect it. We had practised throwing it the way they do at sea, by swinging it round the head, and flattered ourselves we were almost as expert at the business as the leadsman on board a pilot-schooner; but the force of the current was so great as to sweep it down long ere it reached the bottom. We found the bed of the river 8200 feet above the sea.

11*th October.*—Marched to Numgeea, 9 miles. The footpath was good and even upon the bank of the Sutluj. To-day we left the road, to look at the conflux of the Lee with the Sutluj. The Lee is a river of considerable breadth, coming from Ludak on the northward; but it is not very deep, and flows in a clear stream, with a moderate current; whilst the Sutluj is muddy, and runs with great velocity, and a stunning noise. Since leaving Pooave, the trees had gradually become more scanty. In the vicinity of Numgeea there is little vegetation, the grass and thyme are but thinly scattered in small tufts, and a solitary dwarf-pine appears here and there.

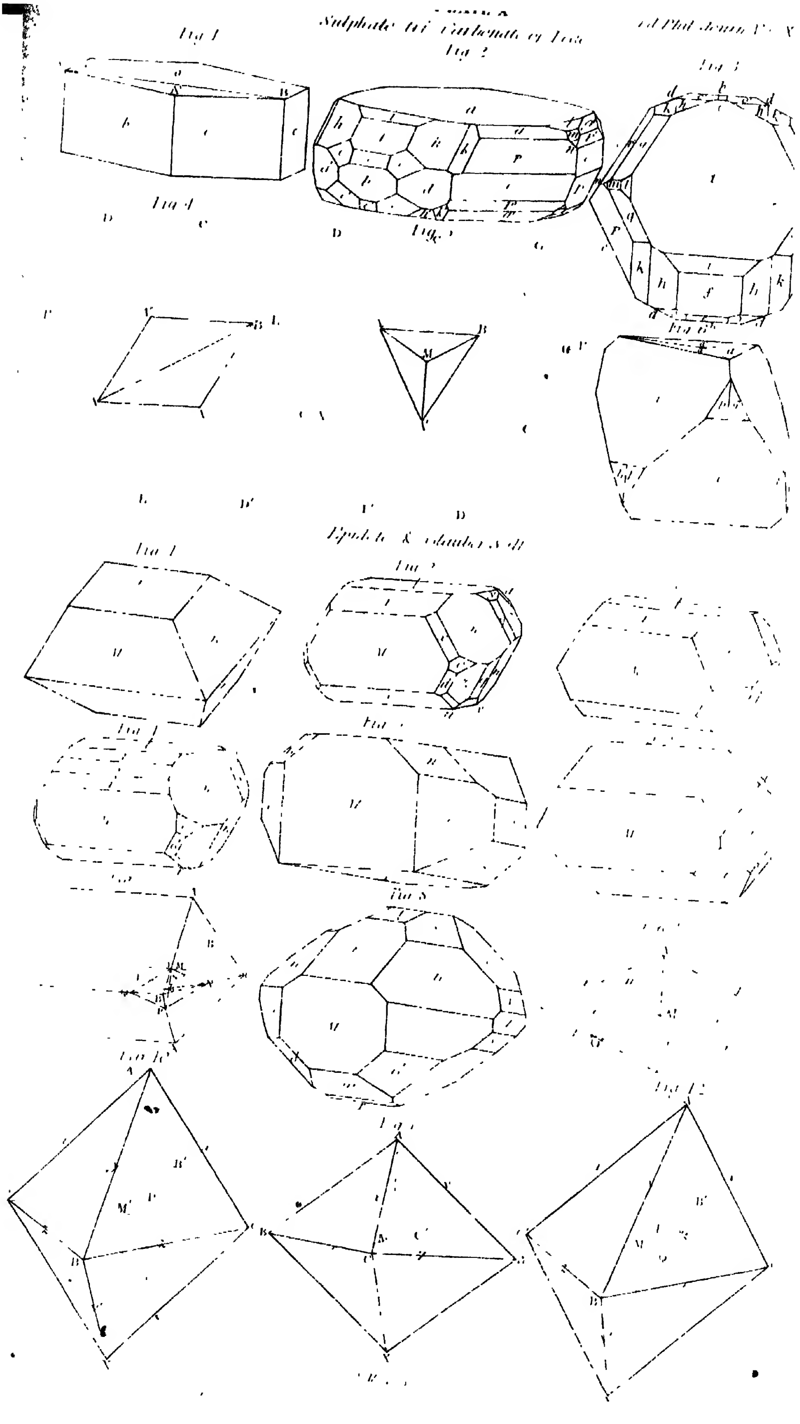
12*th October.*—Marched to Shipke, 9 miles. The road ascended a little, and there was a steep descent into the bed of the Oopsung. Here the rocks are more rugged than any we had yet seen; they are rent in every direction, piled upon one another in wild disorder, in a most extraordinary manner, not to be described, overhanging the path, and threatening destruction to the traveller.

At the pass which separates Koonawur from the Chinese dominions, 13,518 feet above the sea, the scene was entirely changed,—a more marked difference can scarcely exist. The mountains to the eastward were quite of another nature from those we before met with; they are of granite, broken into gravel, forming regular slopes, and neither abrupt nor rocky. The country in that direction has a most desolate and dreary aspect;

not a single tree or blade of green grass was distinguishable for nearly 30 miles, the ground being covered with a very prickly plant, to which we gave the name of whins. This shrub was almost black, seeming as if burnt, and the leaves were so much parched from the arid wind of Tartary, that they might be ground to powder by rubbing them between the hands. The brownish tint of the whins, together with the bleakness of the country, have the appearance of an extensive heath, and must strongly remind a Highlander of his native land. Our course from Brooang Pass was about NE.; here we found we had reached the northernmost point of the Sutluj, in Lat. 31° 50′. It lay about two miles on our left hand; and from this place, its direction, all the way to its source in the famous Lake of Mansuwurer, is nearly ESE. The wind was so strong that we could with difficulty keep our feet; and it is said to blow with almost equal violence throughout the year. We saw some snow on our right, a little below us; and beyond it, a peak, above 20,000 feet high, from which the snow was drifting in showers by the force of the wind.

From the pass to camp, the road was a moderate descent upon gravel, winding very much.

Shipke is a large village, in the small district of Rong-zhoong, under the Deba or Governor of Chubrung, a town, or rather a collection of tents, on the left bank of the Sutluj, eight marches to the eastward. The houses here, which are very much scattered, are built of stone, and flat-roofed; there are gardens before each, hedged with gooseberries, which give them a neat appearance. This is a populous place. We counted upwards of 80 men, who, on our arrival, came to meet us, being the first Europeans they had ever seen. The Tartars pleased us much; they have none of that ferocity of character so commonly ascribed to them; they have something of the Chinese features, and their eyes are small. They all go bare-headed even in the coldest weather, and have their hair plaited into a number of folds, ending in a tail, which reaches to their rumps. Their dress consists of a garment of blanket, trowsers of striped woollen stuff resembling tartan, and stockings or boots of red blanket, to which are sewed leather-shoes. Most of them wear necklaces, upon which are strung pieces of quartz or bone; they have also knives in brass or



silver cases: all carry iron-pipes of the same shape as those used by labourers at home, and the higher classes have them generally ornamented with silver. In common with the inhabitants of Koonawur, the greater part of them have a flint and piece of steel for striking fire, attached to their apparel by a metal chain. The women, whose dress resembles that of the men, were literally groaning under a load of ornaments, which are mostly of iron or brass, inlaid with silver or tin, and beads round their necks, wrists, ancles, &c. and affixed to almost every part of their clothes.

ART. XVIII.—*A comparative View of the Series of Crystallisation of Epidote and of Glauber-Salt.* By WILLIAM HAIDINGER, Esq. F. R. S. E. Communicated by the Author.

VARIOUS opinions have hitherto prevailed among mineralogists relative to the question, whether several species with forms of variable dimensions, possess exactly the same form, or whether they all differ from each other in these respects. This however, is a matter which will probably remain unsettled for some time, although good authorities may be quoted in favour of either of the two different cases. With the exception of those minerals whose forms are comprised in the tessular system, the Abbé Haüy took for granted that every species would have its peculiar series, or, as he used to call it, its peculiar system of crystallisation. This very probable supposition found numerous adherents, and was generally received, when Professor Mitscherlich published his interesting labours on the isomorphous bodies, in which he asserted the perfect identity of the crystalline forms presented by several substances. The followers of a contrary opinion have brought forward instances, where the coincidence of the angles in two different species, containing isomorphous substances in the required proportions, does not take place rigorously; but many accurate observations shew, that at least the differences are sometimes very trifling. Thus, the isomorphous sulphates of zinc and of magnesia ($\dot{Z}n\,\dddot{S}^2$ +

14 Aq and $\ddot{Mg}\,\dddot{S}^2+14$ Aq) possess prismatic forms, the first dependent upon a scalene four-sided pyramid P=127° 27′; 126° 45′; 78° 5′, the other upon P=127° 22′; 126° 48′; 78° 7′: the forms of the two isomorphous species, of rhombohedral Corundum, and of rhombohedral Iron-ore ($\dddot{Al}$ and $\dddot{Fe}$) are derivable from acute rhombohedrons, the first from R=86° 6′, the second from R=85° 58′, &c. But, however striking this coincidence may be, as the differences may lie between the limits of errors of observation, yet there are many instances of isomorphous combinations, where the angles vary beyond these limits, and indicate that it would be too precipitate to assume a perfect equality even for the other. But it will not admit of a doubt, that there really are certain analogies in the forms of crystallisation among certain compounds of analogous substances. Thus, the carbonates of lime, of iron, of manganese, of zinc, of lime and iron, of lime and magnesia, and others, affect rhombohedral forms, and are cleavable parallel to the faces of a finite, obtuse rhombohedron of that system; on the other hand, the carbonates of lime, of lead, of barytes, of strontites, exhibit as remarkable analogies in the prismatic forms which they present, and which extend not only to the relative measures of their angles, and the occurrence of very nearly the same simple forms, but also to the peculiar mode of regular composition, so very frequently found in every one of these substances. If we abstract from the chemical relations, the analogies of the forms still remain, and their consideration becomes a pure crystallographic problem: it will even be necessary to carry the comparison farther than could be indicated by the chemical analysis, and include, for instance, in the comparative consideration of the above mentioned prismatic forms, also those of prismatic Iron-pyrites, of prismatic Melane-glance (brittle Silver-ore), of prismatic Corundum (chrysoberyl), and others, which present very nearly the same peculiarities in their series of crystallisation. In the study of these analogies, though they have been observed by the earliest crystallographers, yet an extensive field is still open to the inquiry of naturalists, and cannot but yield highly interesting results, when carried on with the circumspection which it requires.

There exists a very remarkable analogy of this kind between the crystalline forms of Epidote (prismatoidal Augite-spar) and of Hydrous Sulphate of Soda (prismatic Glauber-salt), as obtained from a recent and more accurate examination of these two substances, in the *Treatise on Mineralogy* by Professor Mohs. The relations of the different simple forms occurring in the two species are almost identical, though the absolute measure of the angles of the one is considerably distant from that of the other.

The crystals of Glauber-salt have been hitherto but imperfectly described. Haüy * ascribed to this species, on the authority of Romé de l'Isle, the form of a square prism, terminated by an isosceles four-sided pyramid, in which he has been followed by a great number of mineralogists. Count Bournon † states the primitive form of the substance to be an oblique-angular four-sided prism of 108° and 72° or nearly so. He came nearer the truth than Haüy, but did not yet establish the hemiprismatic character of the crystalline forms of the species.

The history of the forms of Epidote is not so simple as that of Glauber-salt. Several varieties of the species itself had been formerly comprised under the general name of Schörl, and its forms were compared by Romé de l'Isle to those of Augite, a species which he considered to be nearly allied to Epidote, (paratomous Augite-spar), with this difference only, that the crystals of one of these substances were commonly elongated, and implanted in another direction than those of the other. Supported by his mathematical considerations of forms, Haüy, who first established Epidote into a particular species, gave another position to the crystals of this substance ‡ than that which he assigned to the forms of Augite §. He supposed the elongation of those crystals to take place in the direction of their principal axis, and gave for their primitive form a four-sided prism, of which the transverse section is a rhomboid of 114° 37′ and 65° 23′; the sides of this prism are to each other in the ratio = 110 : 96; and its base is perpendicular to the lateral faces. The analogous position of both substances indicated by Romé de l'Isle, was no doubt preferable, and had Haüy adopted it, he

* *Tabl. Comp.* p. 19.
† *Catalogue*, p. 183.
‡ *Traité*, t. iii. p. 102.
§ *Traité*, t. iii. p. 80.

would have been able to render the description and figures of Epidote as clear and intelligible as those of Pyroxène or Amphibole. As they are, they shew more that their author was intimately acquainted with the subject he treats, than they are adapted to the use of the student. By a decrement of one series of molecules along the acute vertical edge of the primitive form, this prism is changed into an irregular six-sided one, whose transverse section contains two angles of 114° 37′, two of 116° 40′, and two of 128° 43′. The difference between the two first of these angles is expressed in the ratio of the sides of the primitive form, and has suggested to Haüy the name of *Epidote*. This observation is the more remarkable, as the instrument which Haüy employed requires the crystals to be very perfect, in order to perceive the small difference of about 2°. Epidote has been the subject of a particular and very elaborate memoir by Professor Weiss *, in which he re-establishes that analogous position of forms, in which Romé de l'Isle had endeavoured to compare them with the forms of Augite, with this difference, that Romé de l'Isle considered the crystals, of both substances, in that position which Haüy has chosen for epidote, while Weiss has placed them in that which has been given by Haüy to the crystals of pyroxène. This was a considerable step farther in their study, in order to find out analogies with the forms of other substances. Weiss, however, has not been fortunate in fixing upon that situation of the crystals which makes the faces *r*, Fig. 1. Plate X., vertical, or parallel to the principal axis, because in this situation the relations between the simple forms become unnecessarily complicated. Not having himself measured with care the crystals of this substance, he was forced to rely on the data of Haüy. But he referred theoretically the ratios among the different forms occurring in the species to that of three lines perpendicular to each other, and thus it happened that, although more intelligible and easy to be compared with other species, his mode of considering the forms of Epidote is less correct and applicable to nature than that of Haüy.

In the position in which Professor Mohs considers the crystals of Epidote or *prismatoidal Augite-spar* †, the faces *M* cor-

* *Abhandl. d. Akad. d. Wissensch. zu Berlin*, for 1818 and 1819, p. 242.

† *Grundriss der Mineralogie*, *Th.* i, p. 561.

responding to the most perfect cleavage, are parallel to the principal axis of the fundamental form. The faces *r* and *T* belong to a horizontal prism, the first being those on the side of the observer, and the second the other faces contiguous to the same apex of this form. According to accurate measurement by the reflective goniometer, the difference between the two angles formed by the intersection of *M* with *r* and *T* is rather less than that indicated by Haüy, since they are *r* upon $M = 116^\circ\ 17'$, and *T* upon $M = 115^\circ\ 24'$. The incidence of *r* upon *T* is $= 128^\circ\ 56'$. In itself the choice of the position of these forms is quite arbitrary, but that one will be the most eligible which allows the simple forms most easily to be traced to the prismatic forms of other species, by certain analogies, which will be pointed out in another paper. The relations of the simple forms towards each other, developed upon the supposition of the face *M* being $P\breve{r} + \infty$, or a plane parallel to the axis of the fundamental pyramid, are so simple, that there can be no doubt that the position chosen is the one most agreeable to nature. I shall proceed by developing these simple forms in several examples taken from nature.

One of the most ordinary combinations is the *Variété amphihexaèdre* of Haüy, that represented by Fig. 1. It is, at the same time, one of those which contain the least number of simple forms. Besides the above mentioned faces of $+\frac{P\breve{r}}{2}$ (r), $-\frac{P\breve{r}}{2}$ (T), and $P\breve{r} + \infty$ (M), it contains only the faces of $\frac{P}{2}$ or *n*, the intersection of which, over the face *r*, produces an angle of $70^\circ\ 33'$; its supplement, or the angle of incidence of *n* upon *n*, is $= 109^\circ\ 27'$. The angles of this variety are sufficient for calculating the fundamental form, and the angles of all secondary forms relative to this species.

The fundamental form of the species is a scalene four-sided pyramid, Fig. 10., in which AX, the axis of the form, includes with AP, a line perpendicular to the base, an angle of $0^\circ\ 33'$, which, in the method of Mohs, is called the *Inclination of the Axis.* The algebraic formulæ for calculating the angles of this form, are obtained from the values of the four lines AP, MB, MC, and MP, called *a*, *b*, *c*, and *d*. They are,

$$\cos y = \frac{a^2 (b^2 - c^2) - c^2 (b + d)^2}{a^2 (b^2 + c^2) + c^2 (b + d)^2};$$

$$\cos y' = \frac{a^2 (b^2 - c^2) - c^2 (b - d)^2}{a^2 (b^2 + c^2) + c^2 (b - d)^2};$$

$$\cos x = \frac{a^2 (c^2 - b^2) - c^2 (b^2 - d^2)}{\surd[(a^2 (b^2 + c^2) + (b + d)^2 c^2)(a^2 (b^2 + c^2) + (b - d)^2 c^2)]};$$

$$\cos z = \frac{b^2 (c^2 - a^2) - c^2 (a^2 + d^2)}{\surd[(a^2 (b^2 + c^2) + (b + d)^2 c^2)(a^2 (b^2 + c^2) + (b - d)^2 c^2)]};$$

$$\text{tang MAP} = \frac{d}{a}; \ \text{tang BAP} = \frac{b + d}{a}; \ \text{tang B'AP} = \frac{b - d}{a};$$

$$\cos \text{CAC}' = \frac{a^2 + d^2 - c^2}{a^2 + d^2 + c^2}; \ \cos \text{CBC}' = \frac{b^2 - c^2}{b^2 + c^2}.$$

According to these formulæ, and the ratio of the lines $a : b : c : d = 105 : 216.8 : 66.6 : 1$, as corresponding nearest to nature, the angles of the fundamental form are

$$P = \left\{ \begin{matrix} 70° \ 33' \\ 70° \ \ 9' \end{matrix} \right\}; \ 151° \ 3'; \ 117° \ 33'.$$

The angle MAP, or the *inclination of the axis*, is $= 0° \ 33'$. The angle BAM, or the anterior part of the prism $P\overset{\circ}{r}$, which is designated by $\frac{P\overset{\circ}{r}}{2}$, is $= 63° \ 43'$; the angle MAB′, or $-\frac{P\overset{\circ}{r}}{2}$, is $= 64° \ 36'$. The species of epidote is another instance of a very slight inclination of the axis, of which the axotomous lead-baryte has already furnished an example.

Fig. 3. shews a combination of the preceding forms with two new ones, $P - \infty$ (l) and $-\frac{P}{2}$ (z). The relations of these forms are easily obtained from the parallelism of the edges between l, n, and z, and from that between z, n, and M.

Fig. 2. represents a more complicated variety than the two preceding ones, in which, however, the development of the simple forms will likewise follow from the mode in which the edges of combination are situated. It appears immediately that the faces marked q, forming truncations on the obtuse terminal edges of P, must be $= P\bar{r}$, the angle of the terminal edge of which is $= 64° \ 37$. If we suppose all the faces of the combination to disappear except n, z, r, and T, which are known, and o, which is to be developed, the latter will produce a rhombic

face QONP, at the lateral solid angle B, Fig. 7., formed by the meeting of four different faces. Since the diagonals of any rhomb bisect each other, QR will be equal to NR. Draw QT parallel to BM, and TN parallel to MC. The triangles QBR and NSR are equal, and similar to each other; QB, therefore, = SN, and TN = 2. SN. From this rhombic figure it follows, therefore, that the ratio of the lines QT and TN, or b' and c' in a section of the prism o, parallel to the base of P, must be equal to that of BM : 2 MC, Fig. 10., or $= b : 2c$, if, by b and c, we denote the long and the short diagonal of the base of the fundamental form. The sign of the prism o is therefore $(P\breve{r}+\infty)^3$, and its angles of intersection, if the faces meet above the face M, is $= 63° 8'$. Since the faces y of a horizontal prism have exactly the same situation at the other angle of combination, between the faces n, z, r, and T, the ratio of $a' : c'$ for y will be $= \frac{1}{3} a : c$, being expressed by the analogous lines in P; and the form, therefore, to which these faces belong must be $P\bar{r}-1$. The faces noted x have first been described by Weiss. In order to develope the form to which they belong, suppose Fig. 9. to represent a combination of $\pm\frac{P}{2}\left\{\frac{n}{z}\right\}$. $\pm\frac{P\breve{r}}{2}\left\{\frac{r}{T}\right\}$. and $(P\breve{r}+\infty)^3$ (o), projected on a plane parallel to that which passes through the axis and the long diagonal of the fundamental form. As the edges of combination between x and n are parallel to those between n and z, if this face passes through the point A, the edge of combination will coincide with the terminal edge AM of P. Likewise, on account of the parallelism between x, o, and z, the same face will also pass through the edge MO, and AO will be the projection of the terminal edge of the pyramid to which the faces x belong. In this pyramid the ratio of $a' : c'$ is $= a : c$, on account of the coincidence of the two terminal edges in AM. But for the other diagonal we have $b' : a' =$ OQ : QA $= \frac{1}{2} b : \frac{3}{2} a, = b : 3 a$, and consequently for the whole pyramid $a' : b' : c' = 3a : b : 3c$, which makes the sign of $x = \frac{(\breve{P})^3}{2}$; and since d possesses a situation analogous to x, on the opposite side of the fundamental form, the sign of this part of the same pyramid will be $-\frac{(\breve{P})^3}{2}$. For the pyramid u, the

ratio of $a' : b'$, is $= a : b$, on account of the parallelism of the edges between z, u, and r; but, as appears more distinctly in a projection, the intersection of u and M would be parallel to the edge of combination between u and y, and the ratio of $a' : c'$ is therefore $= \frac{1}{2} a : c$. The sign of the half of the pyramid, as occurring in the combination, is $= -\frac{(P\breve{r}-1)^3}{2}$, since the ratio of $a' : b' : c'$ may also be expressed by $\frac{2a}{2} : b : 2c$. The crystallographic sign of the whole combination is

$$\begin{array}{cccccccc} P-\infty . & \frac{P\breve{r}}{2} . & \frac{P}{2} . & \frac{(\breve{P})^3}{2} . & P\bar{r}-1 . & P\bar{r} . & -\frac{P\breve{r}}{2} . & -\frac{(P\breve{r}-1)^3}{2} . \\ l & r & n & x & y & q & T & u \end{array}$$

$$\begin{array}{cccc} -\frac{P}{2} . & -\frac{(\breve{P})^3}{2} . & (P\breve{r}+\infty)^3 . & P\breve{r}+\infty . \\ z & d & o & M . \end{array}$$

The horizontal prisms $\frac{P\breve{r}+1}{2}$ $(s) = 45° \, 37'$, and $\frac{\frac{3}{4}P\breve{r}+2}{2}$ * $(i) = 34° \, 21'$, in Fig. 4., are obtained from immediate measurement. The rest of the forms are known from the preceding combination.

All these varieties have been observed in crystals from Arendal; those from Dauphiny are commonly less complicated, but require perhaps more attention on the part of the observer, because they are so very deeply streaked in a direction parallel to the edges of combination between $P-\infty$ and $P\breve{r}+\infty$. They are besides, in most cases, subject to regular composition. One of these crystals is represented in Fig. 6. It is a combination of $\frac{P\breve{r}}{2}$ (r). $-\frac{P\breve{r}}{2}$ (T). $\frac{P}{2}$ (n). $-\frac{(P\breve{r}-1)^5}{2}$ (u). $P\breve{r}+\infty$ (M), and $P\bar{r}+\infty$ (P). Only the last of these faces is not comprised in any of the preceding varieties.

It is not the purpose of this paper to give a full account of all the simple forms which occur in epidote, far less of the numerous combinations in which they appear, and of the regular

* A variety from Piedmont, in the collection of Mr Allan, contains $-\frac{\frac{3}{4}P\breve{r}+2}{2}$ $= 34° \, 39'$, corresponding to i on the opposite side of the fundamental form.

compositions in which they join parallel to the face of $-\frac{P\breve{r}}{2}$ (T). The preceding observations will suffice for the proposed comparison of its series of crystallisation with that of Glauber-salt.

The same letters which have been employed in marking the faces of crystallisation of Epidote, are made use of also in Glauber-salt, Figs. 5. and 8., for those which are analogous to the forms. It is impossible not to be struck with the almost entire coincidence of the relations among the simple forms, although the absolute measures of the angles are very different. Thus,

In both Species.		In Epidote.	In Glauber-salt.
n	$= \frac{P}{2}$	$= 70° 33'$	$= 93° 12'$
z	$= -\frac{P}{2}$	$= 70° 9'$	$= 81° 10'$
r	$= \frac{P\breve{r}}{2}$	$= 63° 43'$	$= 49° 50'$
T	$= -\frac{P\breve{r}}{2}$	$= 64° 36'$	$= 72° 15'$
d	$= -\frac{(\breve{P})^3}{2}$	$= 96° 15'$	$= 112° 27'$
o	$= (P\breve{r}+\infty)^3$	$= 63° 8'$	$= 86° 31'$
y	$= P\bar{r}-1$	$= 103° 30'$	$= 118° 12'$.

The limits $P-\infty$ (l), $P\breve{r}+\infty$ (M), and $P\bar{r}+\infty$ (P), occur in both. The inclination of the axis, $= 0° 33'$ in Epidote, $= 14° 41'$ in Glauber-salt, takes place in a plane passing through the axis and the long diagonal. The angles of P, the fundamental pyramid itself, are:

$$\text{In Epidote} = \left\{\begin{matrix} 70° 33' \\ 70° 9' \end{matrix}\right\};\ 151° 3';\ 117° 33';$$

$$\text{In Glauber-salt} = \left\{\begin{matrix} 93° 12' \\ 81° 10' \end{matrix}\right\};\ 140° 23';\ 105° 51'.$$

The ratio of the lines $a:b:c:d = 105:216.3:66.6:1$ in Epidote, is $=3.816:7.005:3.188:1$ in Glauber-salt.

The faces of $-\frac{(P\bar{r})^3}{2}$ (v) and of $-\frac{P\breve{r}+1}{2}$ (w) in the latter, have not yet been observed in the former of these species.

But, however remarkable this identity of relations among the simple forms may be, the analogy between the crystals of the two substances will still allow of more points of coincidence. Both species exhibit two faces of cleavage, of different perfection; of which the one, parallel to *M*, is very easily obtained, while the other, parallel to *T*, is less apparent. There are also in both traces of cleavage, parallel to *P*. The crystals of both substances are commonly elongated in the direction of the short diagonal of their fundamental form, and implanted in the same direction.

In prismatic Glauber-salt we may obtain very long prisms of that description from a solution of sulphate of soda, if allowed to cool rapidly, while the crystals produced by a slow evaporation are in general shorter, and present a greater number of well-pronounced additional faces than the former. The facility of obtaining excellent crystals of this substance, render it very valuable for the study of the hemiprismatic forms. These crystals are perfectly limpid, and often of a considerable size. If exposed to the dry atmosphere, they are soon decomposed, and fall into powder; but I have preserved them for many months in their natural state, by keeping them in a cool place, wrapt up in paper, which was occasionally moistened. The decomposition, however, is not so rapid as to be prejudicial to the employment of the reflective goniometer, particularly if care be taken to work at low temperatures. It generally begins at certain points, and from these it spreads, creeping, as it were, over the surface, and through the whole mass of the substance, and thus rendering some parts of the faces of crystallisation perfectly dull, while other parts of the same faces retain their original splendour. The dry or anhydrous sulphate of soda, which is produced by the decomposition of prismatic Glauber-salt in a state of powder, can also be obtained crystallised. It is a well known fact, that the capacity of water for dissolving sulphate of soda arrives at its maximum when the temperature is considerably below the point of ebullition (33° centigr. or $106\frac{1}{4}$° Fahr. according to Gay-Lussac) *; above this temperature crystals are formed in the fluid, which consist of anhydrous sulphate of soda. Their form is that of a scalene four-sided pyramid, Fig. 11., whose

* *Annales de Chimie*, tom. xi. p. 313.

angles have not yet been ascertained, sometimes variously modified, and cleavable with great facility parallel to AC′XC, a plane passing through the axis and the short diagonal of the base. The specific gravity of this salt is = 2.462; its hardness = 2.5, between gypsum and calcareous spar; in both these characters superior to the common hydrous Glauber-salt, whose specific gravity is = 1.481, and its hardness = 1.5...2.0, somewhat lower than gypsum. The forms of the two salts are in the same relation to each other as those of hydrous and anhydrous sulphate of lime (prismatoidal and prismatic gypsum-haloide); and from the circumstance, that the forms of the dry sulphate of soda are prismatic, like those of the dry sulphate of lime, it appears that Glauberite, the combination of both, on account of its hemiprismatic forms, cannot be considered as a mere mechanical mixture of these two substances, as has been supposed by some mineralogists.

The analogy between the forms of Glauber-salt and of Epidote is so striking, that after having compared the crystals of the two species with each other, it would be superfluous to add any farther remarks on the subject. But it will be necessary to say a few words on the *Inclination of the Axis* in hemiprismatic forms, which we have found in one of them to be = 0° 33′, and in the other = 14° 40′, and on the consequences of this important observation.

It is impossible to derive the secondary forms of any of the two preceding species according to any regular process, from a scalene four-sided pyramid, in which, like Fig. 11., the three lines AM, BM, CM, or *a*, *b* and *c*, are perpendicular to each other. But the derivation will be effected with the greatest facility, if we suppose the axis AX, to be inclined to a perpendicular AM upon the base CBC′B′, Fig. 10., at a certain angle, variable according to the species to which the forms refer. This inclination of the axis is implied in some of Haüy's earlier determinations, as, for instance, in those of Epidote, of Gypsum, of Felspar, &c.; but he never established it as a general principle, and his later labours proved that he preferred considering hemiprismatic forms, under such dimensions as would render it possible that equally inclined faces appear on both sides of the axis. Professor Weiss has endeavoured, by slight corrections

in the angles, to transfer into this new shape the relations of the crystalline forms in those species, which Haüy had not yet considered under the same point of view. Supposing the angles given by Haüy not to be exact, he corrected them, although not guided by observation, till the species could be reduced to the anticipated form. Professor Mohs followed an opposite course. Accurate observations, first on Glauber-salt, then on Blue Carbonate of Copper, and on several other species, had shewn that there really were angles which could not be obtained when the axis in the fundamental form was supposed perpendicular upon its base. He introduced, therefore, another mode of considering these hemiprismatic forms, supposing that they are derived from a pyramid like Fig. 10. All the hemiprismatic species, which since that time have been the subject of more accurate inquiry, have yielded results agreeing with the general principle, which supposes that in every hemiprismatic form, the axis will deviate from the perpendicular direction upon the base, for a certain angle, however small this angle may be found. The limits of its range, as obtained from experience, are 0° 29′ in axotomous Lead-baryte, and 22° 49′ in prismatic Brithyne-salt (Glauberite). In many species, which have not been recently examined, the inclination of the axis must be supposed to be = 0: but it is highly probable, that this perpendicular direction of the axis upon the base will not stand the test of observation.

The most important consequence of this fact, when ascertained to a greater generality, will be, that the Systems of Crystallisation, viz. the tessular, the rhombohedral, the pyramidal, and the prismatic system, must be increased by another, which contains the hemiprismatic forms. Then the tetarto-prismatic forms will likewise require to be included within a particular system, in which the fundamental form, Fig. 12., is a scalene four-sided pyramid, whose axis is inclined to the base, not in a plane which is perpendicular to this base, and passes through one of its diagonals, as in hemiprismatic forms, but in a plane which passes through neither of the diagonals of the base, if it is supposed to intersect this base at right angles. The exact direction of the latter has not yet been established in any species by direct observation.

ART. XIX.—*Observations on the Specific Gravity and Temperature of Sea-Water, made during a Voyage from Ceylon to England, in* 1819 *and* 1820. By JOHN DAVY, M. D. F. R. S., &c. &c.

THE following series of observations has been taken from the MS. Journal of Dr Davy, who has kindly entrusted it to us for this purpose. They embrace a very large portion of the earth's surface, and, from the accuracy and sagacity of the able chemist by whom they were made, we have no doubt that they will be regarded by philosophers as forming a valuable addition to our hydrographical knowledge.

The series of experiments commences at Columbo in Ceylon, on the 4th December 1819: and between the 1st of February and the end of June 1820, they were made on board the Eclipse.

Columbo, December 4. 1819.

	Temp. Air.	Temp. Water.	Sp. Gravity.	Wind.
9h A. M.	79°	82°	1.0228	N.
5 P. M.	83	83	1.0230	N.

In both these experiments, the water was taken from the shore below the flag-staff.

Columbo, Dec. 11.

	Air.	Water.	Sp. Gravity.	Wind.
9h A. M.	78°	82°	1.0231	N.

Feb. 4. 1820. On board the Eclipse, N. Lat. 5° 19′, East Long. 80° 10′.

	Air.	Water.	Wind and Weather.
10h A. M.	80°	80°.5	E. gentle, overcast.
12	80	81	NE. do. do. Light rain.
2 P. M.	79	81	NE. Gentle, pretty clear.
5	80	81	NE. by N. Do. do.
8	77	80.5	NE, Do. Little overcast.

These temperatures were taken in sight of land.

Feb. 5. 1820. N. Lat. 4° 10′, East Long. 80° 15′.

	Air.	Water.	Wind.
1h A. M.	79°	80°.5	N. NE. Gentle, pretty clear.
8	76	80.5	Do. overcast, after a heavy shower.
10	77	80.5	Do. raining slightly.
12	79	81	Do. slightly overcast.
2 P. M.	80.5	81.5	Do. rather cloudy.
4	80	82	Do. clear.
6	77	81.5	Do. pretty clear.
8	80	81.5	Do. clear.
10	80	81.5	Do. clear.

By comparing the chronometer and dead reckoning, it appeared that the ship had been in a current flowing towards the west the whole day.

Feb. 6. 1820. N. Lat. 2° 19′, East Long. 81° 14′.

	Air.	Water.	Wind and Weather.
8h A. M.	81°.5	82°	NE. Moderate, a few clouds.
10	82	82	Do. do. do.
12	82.5	82.5	Do. do. do.
2 P. M.	82.5	82.5	Do. do. do.
5	82	82	Do. do. do.
9	81.5	82.5	Do. Clouds collecting. Thunder.

The ship seemed, during this day, to have been in a current from the north.

Feb. 7. 1820. N. Lat. 0° 48′.

	Air.	Water.	Wind and Weather.
10h A. M.	77°	82°	Calm, overcast, rainy.
12	77	82	NE. Raining slightly, overcast.
2 P. M.	78	82.5	Calm, and overcast.
5	75	81.5	W. Very gentle, heavy shower just passed.
9	77.5	82	E. by N. Gentle, pretty clear.

There was much thunder and lightning during the night, and the weather was squally with heavy rain.

Feb. 8. 1820. S. Lat. 0° 5′, East Long. 81° 37.

	Air.	Water.	Wind and Weather.
6½h A. M.	79°	82°.5	NE. Almost calm, clear.
8	81	82.75	Do. do.
10	82	83	Do. Gentle.
12	82	83.5	Do. do. do.
2 P. M.	82.5	84	Do. do. do.
5	84	84.5	Calm, do.

	Air.	Water.	Wind and Weather.
6h P. M.	81°.5	83°.75	Calm, clear.
8	80	83	NW. Almost calm, clear.
10	79	82.5	Do. do. do.

The night was fine, and almost calm.

Feb. 9. 1820. S. Lat. 0° 41, East Long. 81° 49′.

	Air.	Water.	Hygrom.	Wind and Weather.
6½h A. M.	77°	82°.5		W. Very gentle, clear.
8	80	83		W. by S. do. do.
10	81	83		W. gentle do.
12	81	84	6° *	W. by N. do. do.
2 P. M.	78	83	4	NW. squally, raining hard.
6	80	83.5	5	Do. do. cloudy.
10	79	82	3	Do. do. do.

The night was rather squally and cloudy, with occasional showers.

Feb. 10. 1820. S. Lat. 2° 8′, East Long. 81° 54′.

	Air.	Water.	Hygrom.	Wind and Weather.
7h A. M.	77°	81°5	2.5	N. by. W. squally, cloudy, showery.
10	78.5	82	3.5	Do. do.
12	80.5	82	5.5	Do. do.
2 P. M.	82	82	5	Do. do.
6	79	81	4	Do. do.

The night was boisterous, with heavy rain, and some thunder and lightning.

Feb. 11. 1820. S. Lat. 4° 45′, East Long. 81° 54′.

	Air.	Water.	Hygrom.	Wind and Weather.
7h A. M.	79°	81°.5	4°	W. by W. stormy, cloudy.
10	81	82	4.5	W. do. do.
12	79	81.5	4	W. overcast, rainy.
2 P. M.	81	82	4	W. squally, do.
6	78	81.5	2	W. do. raining slightly.
9	79	81.5	4	W. Fresh, pretty clear.

The wind was fresh during the night, and the sky pretty clear, with occasional showers.

* These Hygrometrical observations were made with two thermometers, one of which had its bulb covered with an absorbent substance, and wetted with water. The degrees in the column show the descent of the mercury by the cold, produced by evaporation.

Feb. 12. 1820. S. Lat. 7° 10′, East Long. 82° 26′.

	Air.	Water.	Hygrom.	Wind and Weather.
6½h A. M.	77°	81°.5	2°	W. Fresh, cloudy, raining slightly.
10	80.5	82	5.5	W. by S. do. pretty clear.
12	81	82	5	Do. do. shower coming.
2 P. M.	82	82.5	6	SS.W. Moderate, cloudy
6	80	82	4	SW. very gentle, cloudy, slight rain.
8	81.5	82.5	5.5	SW. do. clear.

The night was rather squally, with some heavy showers.

Between about N. Lat. 3° and S. Lat. 7° or 8°, a north-west or westerly wind prevails during the same month that the north-east wind prevails in Ceylon. About the limits of the NE. and NW., and of the SE. and NW., calms commonly occur. Hence, we may expect, that as those parts of the ocean within the Tropics are particularly liable to calms, the temperature of the water will be unusually high, and that in those parts of the ocean within the Tropics which are particularly liable to squalls, the temperature of the water will be lower. The north-west or little monsoon blows from Madagascar, and the direction is probably connected with that great island. The NW. is succeeded by the SW. monsoon, in the above latitudes.

Feb. 13. 1820. S. Lat. 7° 57′, East Long. 82° 52′.

	Air.	Water.	Hygr.	Wind and Weather.
6½h A. M.	78°.5	83°	2°.5	SW. very gentle, pretty clear.
8	81	83.5	5	Calm, clear.
10	81	83.75	5	SW. by W. very gentle, clear
12	83.5	85		S. by E. do. do.
2 P. M.	82.5	85.5	6.5	SE. do. do.
6	81.5	84.5	6.5	S. do. do.
9	82	83	6	S. by E. do. do.

The night was calm, with frequent showers.

Feb. 14. 1820. S. Lat. 7° 59′, East Long. 82° 20.

	Air.	Water.	Hygr.	Wind and Weather.
6½h A. M.	80°	83°.5	3°.5	SW. Very gentle, cloudy.
10	80	83.5	5	Do. gentle, do.
12	83.5	84.5	7.5	Calm, light clouds.
2 P. M.	80	84	4	S. Fresh, a squall approaching.
6	82	84	6	Calm, light clouds.
9	81.5	83.5	3	S. by E, moderate.

Till midnight there was a fresh breeze, which was followed by a calm and much rain.

Feb. 15. 1820. S. Lat. 8° 34′, East Long. 81° 29′.

	Air.	Water.	Hygr.	Wind and Weather.
6½h A. M.	79°	83°.5	3°	Calm, partially overcast.
10	81	84	4	W. by N. gentle.
12	82	84.5	5	W. by W. do.
2 P. M.	84	85	6	Calm, partially overcast
6	81	84	4	SW. very gentle.
9	80	84	4	Calm, Clear.

The night was clear and calm, and there was some swell from the SE.

Feb. 16. 1820. S. Lat. 9° 3′, East Long. 81°.

	Air.	Water.	Hygr.	Wind and Weather.
6½h A. M.	81°	83°.5	6°	SE. very gentle, pretty clear.
10	85	84.5	8	Do. do. do.
12	85	84.5	8.5	Do. do. do.
2 P. M.	85	85.25	9	Do. do. do.
6	80	84 5	4	N. gentle, dark clouds.
9	82	84	4	Calm, some dark clouds.

The night was calm and fine.

Feb. 17. 1820. S. Lat. 9° 19′, East Long. 80° 39′.

	Air.	Water.	Hygr.	Wind and Weather.
6½h A. M.	80°	83°.5	4°	Calm, pretty clear.
10	83	84.5	6	Do. rather cloudy.
12	83.5	84.5	6	Do. cloudy.
2 P. M.	86	84.5	9	Do. rather cloudy.
6	81	84	3.5	W. gentle do. after a shower.
8	81.5	84	4.5	Do. do.

The night was rather fine, and the wind occasionally approaching to fresh.

Feb. 18. 1820. S. Lat. 10° 8′, East Long. 80° 29′.

	Air.	Water.	Hygr.	Wind and Weather.
7h A. M.	76°	83°.5	2°.5	SW. Gentle, overcast.
10	81	83.5	5	SSW. do. do.
12	82	83.5	6	S. by E. do. slightly overcast.
2 P. M.	81	83.5	5	SW. do. overcast.
6	80	83	6	S. moderately do.
8	80	83	5	S. Gentle, clear.

The night was fine, with little wind.

Feb. 19. 1820. S. Lat. 10° 27′, East Long. 80° 25′.

	Air.	Water.	Hygr.	Wind and Weather.
7h A. M.	80°	83°	4°	Calm, pretty clear.
10	82	84	6	W. NW. very gentle do.
12	84	83.5	7	Do. do. do.
3	83.5	84.5	8	Do. do. do.
6	82	83.5	6	W. by N. gentle, rather clear.
9	78	83	2	Calm, overcast after a shower,

The night was rainy, with little wind.

Feb. 20. 1820.

	Air.	Water.	Evap.	Wind and Weather.
6½h A. M.	77°	82°.5	2°	Calm, overcast.
10	79	83	4	Do. do. do.
12	79	83	3	Variable, very gentle, slight rain.
6 P. M.	76	82	1	W. NW. gentle, overcast.

The night was stormy and rainy, and the wind blowing a gale. During this gale, the sky was thickly overcast, so as to be of a dark grey or light sooty hue, but the sea retained its usual colour. Its blue colour appeared very distinct, when one looked immediately down from the ship into the sea, and it was equally evident in the waves as they rose, their heads being between the light and the eye of the observer. Even in the colour of the surface of the sea in general, a tint of blue might be distinguished, but it was not bright, on account of the darkness of the surface. Hence, we may infer, that the ocean does not owe its blue colour to the reflected azure of the sky, as several authors have supposed.

Art. XX.—*Observations on the Structure and Functions of the Canal of* Petit, *and the Marsupium Nigrum, or peculiar Vascular Tissue traversing the vitreous humour in the Eyes of Birds, Fishes, and Reptiles.* Communicated in a Letter to Dr Brewster, by Robert Knox, M. D. F. R. S. E. &c. &c.

My Dear Sir,

It may perhaps be in your recollection, that in the Essay which I had the honour to read before the Royal Society of Edinburgh, on the Comparative Anatomy of the Eye in June 1823, and in the several memoirs connected with the same subject, which I have subsequently submitted to that learned body, I had not been able to determine, with any precision, the nature and functions of the *pecten* or *marsupium nigrum*, found invariably, I presume, in the eyes of birds. After I had ascertained (what indeed had been done previously), that it is very vascular, and generally dark coloured, that it contains a quantity of loose cellular tissue, and no nerves, and that it seldom proceeds so far as the lens, passing only a certain way into the vitreous humour, I found, that all the questions of high physiological interest, connected with this peculiar structure, still remained unanswered. For example, there did not appear any satisfactory or sufficient reason why this vascular tissue was placed in the centre of the vitreous humour; neither had any one shewn its true functions. To clear up these points, I repeated a number of my dissections, and arranged a series of preparations of the vascular tissues of the eye in birds and quadrupeds, illustrative of some of my opinions. These preparations, together with an Essay on the subject, I had the honour to submit to the Royal Society on the 15th of March. The following very brief Abstract will, I trust, enable the readers of the Philosophical Journal to comprehend the general views I have adopted relative to the subject *.

* The Memoir is not confined altogether to an inquiry into the functions of the Marsupium; several other points relative to the comparative anatomy of the Eye are briefly discussed.

1. *Of the Retina.*

The result of several inquiries which I have made into the structure of this membrane, with the microscope and otherwise, is, that the foramen centrale of the retina is a perforation of the pulpy membrane of the retina, which perforation does not extend to the internal membrane. The functions of this most extraordinary structure in the eyes of man, quadrumanous animals, and certain reptiles, are exceedingly mysterious, and have become, if possible, still more obscure, by the discovery of its presence in the chameleon *.

The anterior termination of the retina is shewn to be nearly as described in my former observations; but the capsules forming the canal of Petit, have been described with a greater degree of minuteness, and, it is hoped, of accuracy. The internal ciliary processes (*Zonula ciliaris* of Zinn.) have been proved to be extremely vascular, and to communicate, by anastomosing vessels, with the *tunica vasculosa retinæ*: these structures exist in their highest degree of development in man and quadrupeds, or, generally speaking, in the mammalia. In birds and certain fishes, another arrangement takes place; the vessels entering into the composition of the tunica vasculosa retinæ, and of the internal ciliary processes of the mammalia, are transferred to the marsupium or pecten: the inner membrane of the retina in these animals is no longer vascular, and seems hardly to exist as a membrane; the complicated structure forming the capsules and canal of Petit has disappeared, and become so completely rudimentary, as to be denied by some anatomists. It is inferred from these and other data, that these are corresponding and analogous parts in the two classes of animals, viz. that the pecten in birds is the vascular portion of the retina, and of the canal of Petit, found only in the mammalia, the functions of which seem to be to secrete and nourish the vitreous humour.

2. *Of the Membrane of Jacob.*

Some speculations relative to this membrane, contained in the

* See a Memoir, entitled, "An Account of the Discovery of the Foramen Centrale Retinæ in the Eyes of certain Reptiles. By R. Knox, M.D." Mem. Wern. Soc. Vol. v. Part i.; also Vol. ix. p. 358. of this Journal.

"Observations on the Comparative Anatomy of the Eye," more careful dissections have not confirmed. It was supposed, for example, that this membrane might be one of the sources of the pigmentum nigrum, but in the most minute vascular injections, prepared with the greatest care, no vessels can be traced to the membrane of Jacob. It is not wanting over the tapetum, as was imagined, but merely becomes transparent, thus altering very singularly its colour, according to the structure and colour of those portions of the choroid with which it is contiguous. Several facts seem to shew, that the membrane of Jacob is altogether inorganic, and analogous to the coloured portion of the *rete mucosum* of the skin.

3. *Of the Annulus albus.*

This body proves to be vascular, and to have a structure somewhat analogous to the iris.

I am, My dear Sir, with great esteem, yours sincerely,

R. Knox.

To Dr Brewster,
Sec. R. S. E. &c. &c.

Art. XXI.—*A short Account of some Observations made in France, to investigate the Parallaxes of the Fixed Stars.*

Two Reports were made, a considerable time ago, one to the French Institute, and the other to the French Board of Longitude, respecting the observations of M. Le Comte D'Assas de Montdardier, Capitaine de Vaisseau, Chevalier de St Louis, &c. &c. for determining the parallax of the fixed stars. These observations have scarcely been heard of in this country; and we extract a short account from the Report to the Board of Longitude, made by M. Delambre, a short time before his death; he, M. de Rossel, and M. Biot, having been appointed a committee for that purpose. The report from the Board of Longitude is much fuller than that to the Institute. Both are very favourable; and it appears, that, in consequence of the report of the

Board of Longitude to the Minister of Marine, that M. D'Assas was promoted from the rank of "Capitaine de Fregat to that of Capitaine de Vaisseau."

M. D'Assas has been engaged for nearly ten years in his laborious observations. The method he has adopted may be considered entirely of his own invention; for, although Galileo suggested something similar, it appears to have been wholly unknown to M. D'Assas, whose method is greatly preferable.

M. D'Assas places an isosceles triangle ABC, Plate VII. Fig. 11., composed of three bars of iron, on a mountain, and observes, by means of a telescope placed in the meridian, between 600 and 700 yards to the northward of the triangle, the occultations of a star at different seasons of the year, at the two equal sides of this triangle. The base of the triangle AC is fifteen times its height BD. He observes, for instance, the occultations at *m*, and that at *n*. Now, if, after some months, the effect of parallax be to elevate the star 1″ in altitude, the interval between the two occultations at *m* and *n* will be changed 1″ in time. Of course, the interval will also be changed from the changes of altitude, arising from variation of refraction, precession, aberration, &c. &c.; but these being known, may be allowed for. M. D'Assas seems well aware of the difficulties attendant on his method, and of the precautions necessary to be taken not to be deceived in his results. The greatest difficulty he feels he has to contend with is from uncertain refractions, as his observations must necessarily be made on low stars, although he has succeeded in observing stars above 30° high. He proposes to use six triangles instead of one, that the mean of the results from the occultations on each day may be more exact.

The report, after stating minutely the precautions taken by M. D'Assas, proceeds to give some of his results. The most remarkable and best founded of them appears to be from his observations of Keid, (40 d. Eridani, 5. Mag.) Rigel, and Sirius. He also observed above 100 other stars; and the number of his observations exceed 4000, affording a wonderful example of labour and perseverance. Each of these observations required delicate and troublesome operations.

To verify his results, he deduces from his observations the annual movements in declination. The great proper motion of

Keid in declination was unknown to him when he commenced his observations. He found it 3″.9 in a year, and afterwards discovered that this was conformable to what M. Piazzi gave for this star. He deduces the parallax of Keid in declination to be nearly 1″, and therefore the whole parallax is about 2″. For Rigel and Sirius he found also sensible parallaxes, but less than in Keid. The annual variations in declination in these stars he found conformable to the results of other astronomers, and thereby proving his observations.

The Report of the Board of Longitude proceeds as follows: "Aucune de ces trois étoiles n'est du nombre de celles dont M. Brinkley a cherché les parallaxes. mais les parallaxes trouvées par les deux auteurs sont si petites, qu'il serait en géneral aussi difficile de les nier que de les affirmer. Pour y croire on peut alléguer le nombre et l'accord des observations qui toutes donnent une parallaxe plus ou moins sensible, tandis qu' aucune ne donne une parallaxe négative, ce qui serait presqu' infailliblement arrivé, si elles étaient les effets des erreurs de l'observation."

The Report of the National Institute concludes as follows: "Le mouvement propre parait donc constaté ; le parallaxe quoique plus faible le serait aussi ; ce qui viendrait à l'appui des parallaxes de 1″ et 2″ que, M. Brinkley trouve á plusieurs étoiles, avec un cercle de 8 pieds, le plus grand qui existe dans tout l'universe.

"D'après la nouveauté de ces resultats, nous ne nous hazarderons à tirer qu'une seule conclusion, c'est que les observations étant faites de part en d'autre avec du soins infinis et par des moyens extraordinaires et si differens ; ces consequences sont dignes de l'attention de tous les astronomes ; qu'il est fort à desirer que les deux auteurs, en continuant ces recherches, en les dirigeant sur un plus grand nombre d' étoiles, puissent parvenir à dissiper tous les doutes et à decider enfin une question que jusqu'ici l'on s'accordait assez géneralement à regarder comme insoluble."

Art. XXII.—*Historical Account of Discoveries respecting the Double Refraction and Polarisation of Light.* (Continued from Vol. IX. p. 152.)

Sect. V. *Account of the Experiments of Dr* Wollaston.

In the Bakerian Lecture for 1801, our learned and ingenious countryman Dr Thomas Young, pointed out the advantages of the Hugenian Theory of Light, in affording an explanation of several phenomena, which had not been accounted for by any other hypothesis. Dr Wollaston, who had invented a new method of measuring the refractive powers of bodies, conceived the idea of employing this method to examine the accuracy of Huygen's Theory of Double Refraction. Huygens had himself done this by direct experiment; but it was desirable to have the same examination repeated by a philosopher of Dr Wollaston's accuracy, and by a method which promised to afford very nice results. In this way Dr Wollaston obtained the following results.

	Index of Refraction.
1. When the line of sight bisects an acute angle of a natural surface of the spar, - - - - -	1.488
2. When the plane of incidence is parallel to one of the sides, - - - - - - - - -	1.518
3. In a direction at right angles with either side, -	1.537
4. In the plane bisecting an obtuse angle, - - -	1.571
5. On a surface perpendicular to the axis of the rhomb,	1.488
6. The regular refraction found by the ordinary method, from an average of several experiments, -	1.657
7. The inclination of two surfaces, - - -	105°.8′
8. Inclination of a refracted perpendicular ray to the perpendicular, - - - - - -	6°.16′

Having obtained these results, Dr Wollaston then contrasts them with those calculated by Haüy.

	Observed.	Calculated.
Exp. 2. -	1.518	1.5215
3. -	1.537	1.539
4. -	1.571	1.5736
Observed angle,	6°.16	6°.7′$\frac{1}{2}$

Dr Wollaston considers the result of this comparison as highly favourable to the Huygenian Theory; and he adds, that though the "existence of two refractions at the same time, and in the same substance, be not well accounted for, and still less their interchange with each other, when a ray of light is made to pass through a second piece of spar, situated transversely to the first; yet the oblique refraction, when considered alone, seems nearly as well explained as any other optical phenomenon *.

Sect. VI. *Account of the Investigations of* M. La Place.

The attention of this illustrious mathematician was no doubt directed to the subject of double refraction, by the labours of Dr Young and Dr Wollaston, who had drawn the attention of the scientific world to this recondite branch of physical science.

These investigations are contained in a memoir, entitled, "*Sur les Mouvemens de la Lumiere dans les Milieux Diaphanes*," which was read at the Institute on the 30th January 1808, and published in their Memoirs for 1809, p. 300,—342.

It occurred to M. La Place, that it would be highly interesting to refer the law of Huygens to attractive and repulsive forces, as Newton had done the ordinary refraction. In employing the principle of least action for this purpose, he remarks, that, in the case of the extraordinary refraction, the velocity of the light within the crystal must be independent of the manner in which it enters, and must depend only on the position of the ray with respect to the axis of the crystal, that is, on the angle which the ray forms with a line parallel to the axis.

In setting out from this datum, M. de La Place arrives at two differential equations given by the principle of least action, and in which the interior velocity is an indeterminate function of the angle, which the refracted ray forms with the axis of the crystal. In the first case which he examines, the square of the velocity of the ray is increased in the interior of the medium by a constant quantity, (which is the case of ordinary transparent mediums), and this constant quantity expresses the action of the medium upon light. The two equations, then, shew that the

* *Phil. Transactions* 1802.

incident and refracted ray are in the same plane, and that the ratio of the sines of their inclination to a vertical line is constant.

In the next case, the action of the medium upon light is equal to a constant quantity, *plus*, a term proportional to the square of the cosine of the angle which the refracted ray forms with the axis; for, as this action is equal on all sides of the axis, it must depend only on the even powers of the sine and co-sine of that angle. The expression of the square of the interior velocity is thus of the same form as that of the action of the medium. By substituting this expression in the differential equation of the principle of least action, M. de La Place then determines the formulæ of refraction in relation to this case, and he finds that they are *identically those which are given by the law of Huygens.* Hence it follows, that the Huygenian law satisfies both the principle of least action, and the condition that the interior velocity depends only on the angle formed by the axis and the refracted ray.

M. de La Place then proceeds to remark, that the hypothesis of Huygens, that the velocity of the ray is expressed by the variable radius of the ellipsoid, does not satisfy the principle of least action, but that it satisfies the principle of Fermat, which consists in this, that the light arrives from a point taken without the crystal, to a point taken within it, in the least time possible. For it is obvious that this principle becomes the same as that of least action, by reversing the expression of the velocity. Hence, both these principles conduct to the law of refraction discovered by Huygens, provided that, in the principle of Fermat, we assume with Huygens the radius of the ellipsoid as a measure of the velocity, and that in the principle of least action, we assume this radius as representing the time employed by light in traversing a determinate space taken for unity.

The identity of the law of Huygens and the principle of Fermat results, as M. de La Place has remarked, from the ingenious way in which Huygens considers the propagation of the waves of light, so that his way of considering it, though very hypothetical, represents nevertheless all the laws of refraction which may be due to attractive and repulsive forces, since the principle of Fermat gives the same laws as that of the least action, by reversing the expression of the velocity.

In a work like this, we cannot find room for the ingenious analysis of La Place. We may merely remark, that the Formulæ which he deduces from the principle of least action, and that of Fermat, are found to be identical with the elegant Formulæ which Malus deduced from the construction of Huygens.

D. B.

ART XXIII.—*Observations on Double Stars.* By M. STRUVE of Dorpat. (Continued from p. 109.)

THE great degree of interest which is now attached to the accurate observation of the colour, magnitude, and relative position of double stars, gives a particular value to the observations of M. Struve. We shall, therefore, continue the series from the *Correspondance Astronomique* of Baron Zach; and in the 3d volume of M. Struve's observations, which have arrived in England, we may expect a continuation of his valuable catalogue.

52. 1 *Dragon.* R. Asc. $17^h\ 3'$. N. Decl. $54°\ 43'$.
5th and 5th Mag.

In 1819, M. Struve observed the difference of R. Asc. to be $= +0''.242$; the angle of position $60°\ 0'$ S. Prec.; and hence the distance was $4''.19$. By two projections he found it to be $4''.5$ and $3''.7$, the mean of which is $4''.1$ *.

Angle of position in	1781.7, =	87° 38′	*Herschel.*
	1803.1, =	50 2	*Ditto.*
	1819.7, =	60 0	*Struve.*

53. α. *Hercules.* R. Asc. $17^h\ 6'$. N. Decl. $14°\ 36'$.
4th and 7th Mag.

This star is the finest double star in the heavens. The largest is yellow, and the smallest blue. By 44 observations, M.

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* Those who have not an opportunity of consulting Sir William Herschel's original papers on Double Stars in the Philosophical Transactions, will find the substance of them in the EDINBURGH ENCYCLOPÆDIA, vol. i. Art. *Astronomy*, or in a more popular form, in the enlarged edition of *Ferguson's Astronomy*, vol. ii. Appendix.—ED.

Struve has fixed the difference of R. Asc. at + 0″.337 in 1819 The angle of position by the wire micrometer is 25° 9′ S. Foll, and by the micrometer of projection, 26° 35′, the mean of which is 26° 6′, a result which does not err 1°. Hence it is very remarkable to find, that Sir W. Herschel had observed an increase of that angle as follows.

Angle of position in	1783.3,	25° 29′	*Herschel.*
	1802.2,	31 38	*Ditto.*
	1804.0,	31 54	*Ditto.*
	1804.5,	32 50	*Ditto.*

According to these results, the angle should have increased 11½° in twenty-three years, and in 1819 it should have been nearly 40°, whereas it is only 26°, almost the same as in 1783. If Sir W. Herschel's observations are correct, and we see no reason to doubt their accuracy, one of the two stars must have moved backwards. M. Struve found their distance to be 5″.61, and their difference of declination — 2″.47.

54. *ρ Hercules.* R. Asc. 17h 17′. N. Decl. 37° 19′. 4th–5th and 5th–6th Mag.

In 1819, the difference of R. Asc. was — 0″.323, and the angle of position 36° 9′ N. Prec. Hence the distance will be 4″.78, and the difference of declination + 2″.82. In 1799, Sir W. Herschel found the distance 2″.967, and the angle of position 30° N. Prec.

55. 61 *Serpentarius.* R. Asc. 17h 35′. N. Decl. 2° 41′. 5th–6th and 6th Mag.

Angle of position in	1781,	-	0° 0′	*Herschel.*
————————	1819,	-	4 5 S. Fol.	*Struve.*
Diff. of R. Asc.	1819,		+ 1″.361	*Ditto.*
Diff. of Decl.	1819,		— 1.43	*Ditto.*
Distance, -	1819,	-	20.44	*Ditto.*
Ditto, -	1781,	-	19.07	*Herschel.*

56. 95 *Hercules.* R. Asc. 17h 53′. N. Decl. 21° 36′. 5th and 5th Mag.

One of these stars is white, and the other yellow. The difference of R. Asc. in 1819 was — 0″.478, and the angle of position 0° 55′ S. Prec. The calculated distance is 7″.04, and the

difference of declination — 1″.17. Sir W. Herschel found the angle of position to be 4° S. Prec.

57. 73 *Serpentarius.* R. Asc. 18ʰ 0′. N. Decl. 3° 57′. 6th and 8th Mag.

Sir W. Herschel observes, that he could scarcely see this double star, of an oblong shape, with a power of 227, and that it required a power of 460 to see it double. M. Struve supposes that the distance has increased, as he can easily distinguish them with a power of 126. He found the angle of position to be 5° 1′ S. Prec. a mean of three observations. Sir W. Herschel found it to be 2° 48′.

58. θ 59 *Serpent.* R. Asc. 18ʰ 18′. N. Decl. 0° 5′. 5th and 8th Mag.

These stars have very fine colours, the one being *yellowish*, and the other of a fine *blue* colour. The difference of R. Asc. in 1819 was — 0″.192, and the angle of position 40° 3′, N. Prec. Hence the distance is 3″.66. Sir W. Herschel found the angle of position to be 45° N. Prec., and in 1802 the distance was considerably increased, though the angle remained the same. This observation is confirmed by M. Struve.

59. ε and 5 *Lyra.* R. Asc. 18ʰ 38′. N. Decl. 39° 27′. 5th and 6th–7th Mag., and 5th and 5th Mag.

There are here two double stars, which M. Struve observed as follows.

	ε *Lyra*, 5th and 6th–7th mag.	5 *Lyra*, 5th and 5th mag.
Diff. of R. Asc.	+ 0″.106	+ 0″.088
Angle of position,	60° 7 N. Foll.	70° 3 S. Foll.

The distances by projection observed once, were, for ε = 3″.83, and for 5 *Lyra* = 3″.43. Sir W. Herschel conjectured that the angle of position changed. The angles of position were,

ε *Lyra*,	in 1779,	56° 5′ S. Foll.	5 *Lyra*,	83° 28′
	1804,	59 14		75 35
	1819,	60 42		70 18

60. *β Lyra.* R. Asc. 18h 43′. N. Decl. 33° 10′.

This star is quadruple. The *first* is of the 9th Mag., the *second* of the 3d or 4th Mag., the *third* of the 6th Mag., and the *fourth* of the 10th Mag. The following are M. Struve's observations.

	1st and 2d.	2d and 3d.	2d and 4th.
Diff. of R. Asc.	— 3″.06	+ 1″.895	2″.336
Angles of position,	48° 6 N. Prec.	60° 15 S. Foll.	67° 6 N. Foll.
Distances,	66″.6	47″.8	77″.0
Diff. of Decl.	+ 49″.9	— 41″.5	71″.2

Sir W. Herschel observed only the distance between the second and third in 1779, and found it 48″.95, and the angle of position 60° S. Foll., which agrees nearly with Struve's observations.

61. *η Eagle.* R. Asc. 18h 51′. N. Decl. 13° 23′.
5th–6th and 10th–11th Mag.

These stars are difficult to observe. In 1819, the difference of R. Asc. was — 1″.215, and the angle of position 33°.9 S. Prec. Hence the distance is 21″.35, and the difference of declination — 11″.91. In 1781, Sir W. Herschel found the distance to be only 7″. He did not observe the angle of position. He could with difficulty see the small star with a magnifying power of 227.

62. 56 *Dragon.* R. Asc. 19h 5′. N. Decl. 76° 47′.

Sir W. Herschel remarks, that the two stars are nearly of equal magnitude. M. Struve has never been able to see it double, though he has often examined it with great care.

63. *η Lyra.* R. Asc. 19h 8′. N. Decl. 38° 51′.
5th and 8th Mag.

The difference of R. Asc. in 1819 was + 2′.41, the angle of position 5° 6′ N. Foll.; and hence the distance is 28″.3, and the difference of declination 2″.76. The angle has changed very remarkably since the time of Sir W. Herschel, since he found it to be 32° S. Prec. or 212° in 1779,7 and M. Struve observed it to be 5° 6 N. Foll., or 5° 36 in 1819,9. Such a variation in 40 years, seems very strange. M. Struve conjectures that Sir

William's observations may be affected with some error. Christian Mayer is said to have observed this star.

64. *β Swan.* R. Asc. 19h 24′. N. Decl. 27° 35′.
4th and 5th Mag.

One of these stars is yellow, and the other blue. The difference of Right Ascension is + 2″.208, and the angle of position 35° 36 N. Following. Hence the distance is 35″.96, and the difference of declination + 20″.67. Sir W. Herschel has found the same angle of position, but the distance is a little greater, viz. 39″.53. It appears, however, from Bradley's observations, that the distance has not increased since his time, as he found the difference of Right Ascension to be + 32″.5, and that of declination + 18″.3. Hence the distance is 34″.2.

65. *ι Arrow.* R. Asc. 19h 29′. N. Decl. 16° 4′.
4th–5th and 7th–8th Mag.

M. Struve found the difference of R. Ascension to be 6″.27, and the angle of position 9° 1′ N. Foll. Hence the distance is 1′ 31″.5, and the difference of declination 14″.48. Sir W. Herschel found the angle of position to be 9° S. Foll.; so that the change seems to have been 18°. There may be an error of S. in place of N here.

66. *α Eagle.* R. Asc. 19h 42′. N. Declin. 8° 24′.
1st–2d and 10th–11th Mag.

The small star is very difficult to see. M. Struve found the difference of R. Asc. to be 5″.45 in 1819, and the angle of position to be 57° 8 N. Preced. Hence the distance is 2′ 19″.1, and the difference of declination + 2′ 5″.2. Sir W. Herschel had observed the distance in 1781,6 to be 2′ 23″.3, and the angle 65° N. Prec. Hence the difference of R. Ascension is 67″.5, or 4″.50 in time. The difference of declination is + 2′ 9″.9, and consequently the relative motion in 38,2 years will be + 14″.25 in R. Asc. and — 4″.7 in declination. The following are the absolute motions in 38,1 years, according to Bradley's observations:

For α Eagle,	+ 21″.60 in R. Asc.	+ 17″.4 in Decl.
For its comes,	+ 35″.85	12″.7

M. Struve is disposed to believe that the two stars belong to the same system of attraction, since the proper motion of both is in the same direction.

67. 57 *Eagle.* R. Asc. 19h 45′. S. Decl. 8° 42′. 6th and 7th Mag.

The difference of R. Ascension observed in 1819 is + 0″.29, and that in declination 5′. Hence the angle of position is 78° S. Foll. Sir W. Herschel makes the angle 82° S. Prec.; so that the angle has changed about 20°.

68. ψ *Swan.* R. Asc. 19h 51′. N. Decl. 51° 58′. 4th and 7th Mag.

The small star precedes the great one to the south. Their distance is two diameters of the great star. M. Struve computes the angle of position to be 90° S. Prec. Sir W. Herschel made it 89° 30′ N. Prec. Hence, there has been a change of 180°.

69. χ *Cepheus.* R. Asc. 20h 15′. N. Decl. 77° 10′.

In 1818 and 1819 M. Struve found the difference of R. Asc. to be + 1″.79, the angle of position 36° 2′ S. Fol., and the distance 7″.08. Sir W. Herschel makes the angle of position 32° 30′, and the distance 7″.08.

70. 15 *Dolphin.* R. Asc. 20h 22′. N. Decl. 10° 45′. 6th and 6th–7th Mag.

The difference of R. Asc. is — 0″.95, the angle of position 15° S. Prec., and the distance 14″.5. Sir W. Herschel found the distance in 1779 to be 12″.5, and the angle of position 10° S. Prec.

71. 52 *Swan.* R. Asc. 20h 37′. N. Decl. 30° 4′. 4th and 9th Mag.

The difference of R. Asc. is + 0″.48; the angle of position 35° 9 N. Foll.; and hence the distance is 7″.69. In 1780, Sir W. Herschel observed this angle to be 28° N. Following.

72. γ *Dolphin.* R. Asc. 20^h 38′. N. Decl. 15° 29′. 4th–5th and 5th–6th Mag.

The difference of R. Asc. is — 0″.86, and the angle of position 4° 42′ N. Prec.; the distance 12″.54, and the difference of declination + 1″.03. There seems to be no reason to suppose along with Sir W. Herschel that one of these stars has a proper motion.

73. ε 1, *Little Horse.* R. Asc. 20^h 50′. N. Decl. 3° 36′. 5th and 7th Mag.

The difference in R. Asc. in 1819 is + 0″.746; the angle of position 10° 15′ N. Foll.; and hence the distance is 11″.35. Sir W. Herschel found the distance 9″.379, and the angle of position 6° N. Foll.

74. δ *Little Horse.* R. Asc. 21^h 6′. N. Decl. 9° 17′.

The small star is very difficult to be seen, and M. Struve has not yet been able to see it with his meridian telescope. He estimates the angle of position to be about 40° N. Foll. Sir W. Herschel found it to be 12° N. Foll. in 1781. It has therefore undergone a great change.

75. β *Cepheus.* R. Asc. 21^h 26′. N. Decl. 69° 46′. 3d and 9th Mag.

In 1818 and 1819 the difference of R. Asc. was — 2″.409, and the angle of position in 1820 was 20° 6′ S. Prec. Hence the distance will be 13″.31. The angle of position given by Sir W. Herschel is 5° less than that of M. Struve.

76. μ *Cepheus.* R. Asc. 21^h 49′. N. Decl. 55° 44′. 6th and 11th Mag.

Sir W. Herschel observed that this star was composed of two equal ones, at a distance of 21″.05, with an angle of position of 77° 48′ S. Prec. M. Struve observed this star very often in 1819, but has never succeeded in discovering its companion. He saw a star of the 11th magnitude, but it was distant 7″.49 in time from the other.

77. ζ *Aquarius.* R. Asc. 22^h 19′. N. Decl. 0° 57′. 4th Mag. and 4th–5th Mag.

This star is well known. Sir W. Herschel says that the two are equal. M. Struve considers the most northern as the smallest, and distant from the other a diameter of the star. The following are the angles of position:

1779.9,	-	71° 5′ N. Foll.	= 71° 5′ *Herschel.*
1781.7,	-	71 39 — —	= 71 39 *Ditto.*
1784.5,	-	72 7 — —	= 72 7 *Ditto.*
1802.0,	-	78 3 — —	= 78 3 *Ditto.*
1819.6,	-	88 0 N. Prec.	= 92 0 *Struve.*

The motion in the angle of position seems to have accelerated. Before 1802, it had changed 6° 58′ in 22.1 years; but after 1802, it changed 13° 57′ in 17.6 years.

Art. XXIV.—*Observations on the Comparative Anatomy of the Eye.* By Robert Knox, M. D. F. R. S. Ed. &c. &c.

In the volume of the Transactions of the Royal Society of Edinburgh, which has just appeared, Dr Knox has published an elaborate Memoir on the Comparative Anatomy of the Eye, of which the following is a brief abstract.

In the first section of the Memoir, Dr Knox has considered the subject of vision generally, examining carefully the opinions of some very distinguished physiologists, and more particularly those of Baron Cuvier. It appears to Dr Knox, that we owe to Dr Porterfield the opinion, admitting almost of demonstration, that within certain limits, perhaps within the range of very distinct vision, our knowledge of distance is perfect, and depends on the organ being double and symmetrical. Beyond this point, which in man is very limited, the mode by which we judge of distance becomes complex; we avail ourselves of other senses, more particularly that of touch, and thus acquire experience.

Without doubt the faculty by which the same individual may distinguish the same object at different distances, whilst it is the most important function of the eye-ball, is the one most difficult of explanation. It is evident that the eye must have

the power of changing the position of its parts by some means or other, and these must be placed either within it, or exteriorly to it. It would be tedious to enumerate all the various opinions which have been entertained on this subject, most of which have either been directly refuted by an appeal to facts, or, from being evidently defective and imperfect, have been suffered to fall into merited oblivion. Every one knows that this function has by some been assigned to the iris; by others to the ciliary ligament; to the ciliary processes; to the lens; to the external muscles of the eye-ball; and even to the marsupium,—a very singular opinion, since the marsupium being limited to birds and certain fishes, it remained to be shewn by what structure the function was performed in the other classes of vertebral animals.

Mr John Hunter, to whom physiology is so greatly indebted, was engaged, a short time previous to his death, in the investigation of this subject. The appearance of the lens in the cuttle-fish seemed strongly to have arrested his attention, and he seemed inclined to attach to the structure of this humor of the eye, an importance which further inquiry would have shewn to be unmerited. Dr Knox has endeavoured to demonstrate, that the changes which take place in the interior of the eye, by which we are enabled to perceive objects at various distances, are effected by means of the ciliary muscle, or that body which anatomists have hitherto called the Ciliary Ligament, Annulus albus, &c. To prove this satisfactorily, required a most extensive series of dissections, during the performance of which, the prevailing errors regarding the nature of the ciliary muscle became more and more apparent. It is true, that many writers have considered the annulus albus as muscular, and founded thereon ingenious speculations; but as their opinion rested, for the most part, on bare assertion, so it was very generally, or almost universally, neglected by modern physiologists. It will be necessary to state here only a few of the facts supporting this opinion.

1. The development of the ciliary muscle follows the ratio of the strength of vision, or rather of the accommodating powers of the eye, in the various classes of animals; *i.e.* it is strong in birds, in men, in the quadrumana, and in the deer, weaker in some others of the ruminantia, as the ox; still more so in the

horse. Lastly, In most fishes, it is completely rudimentary, and is reduced to a mere ligament.

2. When examined by the microscope, it puts on the same appearance as the iris, and presents the same arrangement of particles. Now, the iris is avowedly muscular, or at least possesses the power of extensive motion; and this at the least must be granted, even supposing the celebrated sphincter, and radiated fibres of the iris to be a pure fiction.

3. The anatomist has only to examine the ciliary muscle in the eyes of birds, and in the fallow-deer, to be satisfied, that whether the ciliary circle be muscular or not, it cannot possibly be a ligament.

Lastly, In most birds, and in many of the mammalia, as in the quadrumanous and canine animals, numerous nerves can readily be demonstrated, proceeding to the ciliary muscle, and distributed throughout its substance. Now, every one knows, that ligaments are not supplied with nerves, or at least that the nervous fibrils proceeding to them, are so minute as entirely to escape the observation of the anatomist; but the circular body, which hitherto hath been called the Ciliary Ligament, is abundantly supplied with nerves, in a ratio proportioned to the accommodating powers of the eye. In birds these nerves are very numerous, almost equalling in number the branches distributed to the iris. In the deer, and in apes, they may be very readily traced. The supply of nerves to the ciliary muscle in the eye of the horse is less abundant, though still very distinct; but in fishes, where the ciliary muscle has altogether disappeared, or assumed the form and functions of a ligament, these nerves do not exist. This accords with the facts of pathological anatomy, which teach us, that wherever the nerves supplying an extremity are wanting, the muscular system of that extremity has also disappeared.

Whilst describing the sclerotica and transparent cornea, Dr Knox has endeavoured to unravel the true anatomical connections of these membranes; the reflected membrane of the choroid investing the inner surface of the sclerotic; the mode of union between the sclerotic and cornea, and the existence of a reflected membrane from the latter covering the anterior surface of the iris in fishes, and in most birds. In the mammalia, the

anterior layer of the iris is connected with the inner membrane of the cornea, by numerous short fibres, the exact nature of which is as yet unknown. From this distribution of the inner membrane of the cornea (generally described as the tunic of the aqueous humour), it follows, that, during the strong contraction of the pupil, in viewing objects placed close to the eye, the form of the aqueous humour must be considerably affected.

In the very lengthened section on the choroides, and its appendages, the whole of its structure has been carefully re-examined, and, it is hoped, its true anatomy pointed out. Dr Knox has endeavoured to prove, that the marsupium in birds and fishes is simply a reflected membrane of the choroid, and has traced its functions, and the cause of its disappearance, in the mammalia. The connection of the ciliary fibres, those numerous, delicate, fibrous-looking bodies, placed immediately over the capsule of Petit, is shewn to be different from what is usually understood; and that they ought to be considered rather as membranous folds, quite analogous to the folds of the inner membrane of the choroid coat, and ultimately terminating in processes also analogous to those termed Ciliary. The manner in which these internal, or colourless ciliary processes, are connected with the external or true ones, and their importance in the anatomy of the humors of the eye, have been demonstrated at considerable length. It is obvious, that the details could not, with propriety, be introduced into this brief notice. These membranous folds have lately been supposed to be muscular, or at least it has been conjectured that muscular fibres exist in this situation; but analogy, as well as ocular demonstration, are against this opinion.

As fishes have no true iris, neither have they any ciliary nerves. The connection of the iris with the ciliary muscle, and with the neighbouring parts generally, is shewn to be somewhat different in the eyes of the mammalia from what is usually demonstrated passing around the globe of the eye, which seems hitherto to have escaped notice. In birds, this canal is situated immediately over the great plexus of nerves, and may readily be distended with the blowpipe. In the mammalia it is less in diameter, but still sufficiently distinct; it is in some animals partly filled up with a very loose dark-coloured cellular membrane.

In describing the mode in which the optic nerve enters the eye, that of birds has been more particularly attended to, without, however, neglecting the mammalia and fishes. During this part of the investigation, a very singular fact was discovered, viz. that the eye of the deer approaches in many respects to that of the bird, and forms the connecting link in these very different classes of animals.

The last section treats of the ciliary nerves and their distribution; it was necessary, first, to refute the opinion recently adopted by some Continental anatomists, that the body which Dr Knox has called the Ciliary Muscle, is a nervous ganglion or plexus. Now, in order to refute this very erroneous notion, it was only required to examine the eyes of birds, of the deer, of any of the quadrumana, or of man himself, with due attention. It was evident that there exists a true nervous plexus only in birds, and that this plexus is situated anteriorly to the ciliary muscle, to which it sends numerous nerves.

Dr Knox has entered into a few speculations relative to the movements of the iris, and of the nature of the ciliary nerves, and of the lenticular ganglion, of which we cannot pretend to give any account in this brief notice. It has, besides, necessarily happened, that, in drawing up this short abstract, numerous facts, tending to throw light on the physiology of the eye, have been omitted; these will be found detailed in the original memoir, which is published in the Transactions of the Society.

Art. XXV.—*Appendix to the Essay on the Influence of Magnetism on the Rates of Chronometers, published in* No. XIX. By George Harvey, Esq. F. R. S. Edin. &c. Communicated by the Author.

Owing to an accidental circumstance, the details of the following experiments were omitted in the Essay on the Influence of Magnetism on the Rates of Chronometers, published in the last Number of the Edinburgh Philosophical Journal; and I should therefore feel obliged by their being added to it, as supplementary observations.

The time-keeper F, having a detached rate of $+ 2''.0$, was placed on the centre of the circular magnetic plate alluded to in

in the before-mentioned paper, with XII pointing to the south, when the mean of six days' observations gave an average rate of + 7″.3; but on turning the time-keeper a quadrant, so as to bring XII to the west, the daily aberration for seven days became — 3″.6; and on turning it through another quarter of a circle, it received the large increment of 28″.4, the rate for five days in this position being + 24″.8; and on moving it through a fourth quadrant, it underwent a decrement of 19″.8; the rate in this last position being + 5″.0. Of these changes, the most remarkable is that which resulted from placing XII to the north. The variations of rate are recorded in the following Table.

Situation of the Chronometer.	Daily Rate.
Detached.	+ 2″.0
XII S.	+ 7″.3
XII W.	— 3″.6
XII N.	+ 24″.8
XII E.	+ 5″.0

Another considerable alteration of rate took place, by removing the time-keeper from the surface of the magnetized plate, and applying it to the edge, with the hour of X in contact with the north pole; the rate, under this new circumstance, changing from + 5″.0 to — 6″.8; but on turning the chronometer a quadrant, so as to bring VII into contact with the pole, the daily variation amounted to + 7″.9; and on continuing the movement through another quadrantal space, making the hour of IV touch the pole, the rate became + 2″.3.

The next experiment was with the time-keeper G, which being placed on the surface of the same magnetized plate, with XII to the north, altered its rate from — 4″.1, its daily change when detached, to + 0″.1. On turning the chronometer a quadrant, in order to bring XII to the east, the rate declined to — 8″.6; and by moving it through a like space, to cause XII to point to the south, the rate became — 3″.7; and through another similar arc, making XII point west, — 4″.4. On restoring the time-keeper to its first position, *i. e.* with XII directed north, the rate became + 2″.2; and on returning it to

its preceding position, — 4″.7, agreeing within — 0″.3 of its former rate. These results are arranged in the next Table.

Situation of the Chronometer.	Daily Rate.
Detached.	— 4″.1
XII N.	+ 0″.1
XII E.	— 8″.6
XII S.	— 3″.7
XII W.	— 4″.4
XII N.	+ 2″.2
XII W.	— 4″.7

By examining the several rates of the time-keepers F and G, it appears, that they *lost* by having XII turned from N. to E.; *gained* by being turned from E. to S.; *lost* from S. to W.; and *gained* from W. to N.; the changes from *plus* to *minus* being alternate, as shewn in the succeeding Table.

By turning the Chronometer	The alteration of Rate was
From N. to E.	—
...... E. to S.	+
...... S. to W.	—
...... W. to N.	+

In another set of experiments with chronometer H, placed on the middle of an irregular eight-sided magnetic plate, the changes were precisely the reverse of those recorded in the preceding Table, as particularly shewn in the next Table.

By turning the Chronometer	The alteration of Rate was
From N. to E.	+
...... E. to S.	—
...... S. to W.	+
...... W. to N.	—

and which was verified by the following experiments.

By placing the time-keeper on the last-mentioned magnetised plate, with XII pointing south, it was found that its detached rate of — 0″.6 was changed to + 3″.0; and by turning it, so as to bring XII to the west, the last rate was increased to + 16″.9; and moving it through another quadrant, having XII to the north, the rate became + 5″.1; and by turning it through a fourth quadrant, bringing XII to the east, the daily variation became + 20″.4. These results are arranged in the next Table

Situation of the Chronometer.	Daily Rate.
Detached.	— 0″.6
XII S.	+ 3″.0
XII W.	+ 16″.9
XII N.	+ 5″.1
XII E.	+ 20″.4

During the observations with the preceding chronometer, it was remarked, that the difference even of ⅛th of an inch, in the position of the chronometer on the magnetised plate, was constantly accompanied by a sensible alteration of rate. In the experiment immediately succeeding the last recorded, the time-keeper was removed a quarter of an inch from the situation it then occupied, towards the north pole of the magnet, when its daily rate, with XII pointing south, was + 3″.5, it having been only + 3″.0 in the preceding experiment. On turning the machine through a quadrant, so as to bring XII to the west, the daily variation was increased to + 23″.7; and on moving it through another similar space, to make XII point north, the daily rate became + 6″.7; and by moving XII round to the east, this last rate was augmented to + 22″.6; and on restoring the position of the chronometer, with XII directed to the south, the daily variation became + 4″.1, agreeing within + 0″.6 of its rate in the same position in the early part of the experiment.

Hence it appears, that the rates possessed by the time-keeper during its first positions on the magnetised plate, were all augmented by moving it nearer to the north pole, and that the

most considerable alterations resulted therefrom, in the east and west positions of the time-keeper, when the line drawn from the axis of the chronometer to the centre of the balance was at right angles to the meridian of the magnetised plate. The smallest changes also were produced in those situations of the chronometers corresponding to north and south, the centre of the balance being in those situations of the machine, in the magnetic axis of the plate. The changes produced in the rate from the two positions of the chronometer, are recorded in the final Table.

Situation of the Chronometer.	Daily Rates in the First Position.	Daily Rates in the Second Position.
XII N.	+ 5″.1	+ 6″.7
XII E.	+ 20″.4	+ 22″.6
XII S.	+ 3″.0	+ 3″.5
XII W.	+ 16″.9	+ 23″.7

Plymouth, Feb. 16. 1824.

Art. XXVI.—*Analysis of the Transactions of the Royal Society of Edinburgh, Vol. X. Part I.*

THE Part of the Edinburgh Transactions which has just appeared, contains fifteen papers, illustrated by nine plates. The following brief analysis of these papers, with their titles, will convey to our readers some idea of their contents.

1. *On the Existence of Two New Fluids in the Cavities of Minerals, which are immiscible, and possess remarkable Physical Properties.* By David Brewster, LL.D. F.R.S. Lond. & Sec. R. S. Edin.—P. 1–41.

In the preceding Numbers of this Journal, we have already given an abstract of the first seven sections of this paper. In the 8th section, which treats of the phenomena of a single fluid

in the cavities of minerals and artificial crystals, the author describes seventeen specimens of minerals and artificial crystals which contain cavities generally filled with water. One of the finest of these specimens is from the cabinet of Mr Thomson of Forth Street, and which originally belonged to the King of Kandy. Besides an aqueous fluid, the cavity contains several pieces of opaque solid matter, which, with a little management, may be seen falling from one side of it to the other. The particular descriptions contained in this section, can only be understood from the drawings which accompany the paper.

2. *Observations on the Comparative Anatomy of the Eye.* By Robert Knox, M. D. Member of the Wernerian Society, and of the Medico-Chirurgical Society of Edinburgh.—P. 43–78.

An abstract of this paper is given in the present Number of this Journal, p. 338.

3. *Notice of an undescribed Vitrified Fort, in the Burnt Isles, in the Kyles of Bute.* By James Smith, Esq. of Jordanhall, F. R. S. E.—P. 79–81.

This fort occurs on the most northerly of the Burnt Isles of the Kyles of Bute. The island is a flat gneiss rock, with about half an acre of vegetable soil on its summit. The fort stands on the southern or highest extremity, and is only twelve or fifteen feet above high-water mark. The walls form a circle, or rather an irregular polygon, about sixty-five feet in diameter, and occupy nearly the whole of the highest end of the island. Mr Smith traced the vitrified matter all round, and is of opinion that the walls were originally about five feet thick. They appeared to him to be entirely composed of the gneiss, which forms the rock of this and the neighbouring islands. Some of the stones are slightly glazed, whilst in others the felspar appears to be converted into a dark brown glass, either run into considerable masses, or into veins alternating with the strata of quartz, which has become granular like freestone. The vitrified matter sometimes forms a white enamel. Mr Smith is of opinion, that these buildings were probably constructed at a pe-

riod before the country was cleared of its original forests, when the inhabitants were led to cement stones by fusion, from their ignorance of other methods.

4. *On the Formation of Chalcedony.* By Sir G. S. MACKENZIE, Bart. F. R. S. Lond. & Edin.—P. 82–105.

In this paper Sir G. Mackenzie divides the different chalcedonies into Massive, Parallel, Botryoidal, and Pendulous. He considers most of these varieties as of igneous origin, and he conceives that the pendulous chalcedony may have been formed from vapour. As the greater part of this paper consists of the description of highly interesting specimens in the collection of the learned Baronet, it is not easy to put the reader in possession of the curious facts which he has observed. We must, therefore, refer him to the memoir itself.

5. *Notice respecting the Vertebra of a Whale found in a Bed of bluish Clay, near Dingwall.* By Sir G. S. MACKENZIE, F. R. S. Lond. & Edin. In a Letter to Dr Brewster, Sec. R. S. Ed. &c.—P. 105, 106.

A brief notice of this paper has already appeared in vol. xvii. p. 185. of this Journal.

6. *Description of Hopeite, a New Mineral from Altenberg, near Aix-la-Chapelle.* By DAVID BREWSTER, LL.D. F. R. S. Lond. & Sec. R. S. Edin.—P. 107–111.

This mineral was considered by the Abbé Haüy as a Stilbite, and by Mr Brooke as silicate of zinc; but, by an examination of its optical characters, Dr Brewster found it to be a mineral entirely new, to which he gave the name of *Hopeite*, in compliment to Dr Hope, the eminent Professor of Chemistry in the University of Edinburgh. This opinion was afterwards confirmed by a crystallographic examination of the mineral by Mr Haidinger, and by a chemical examination of it with the blowpipe by M. Nordenskjold of Abo.

7. *Astronomical Observations made at Paramatta and Sydney.* By his Excellency Sir THOMAS BRISBANE, K. C. B. F.R.S.

Lond. & Ed. and M. Rumker. In a Letter to Dr Brewster, Sec. R. S. Edin.—P. 112–116.

This interesting paper contains the elliptic elements of the comet of September 1822. It contains also observations of the transit of Mercury over the Sun, on the 3d November 1822, as observed both at Sydney and Paramatta; and likewise the observations of the Winter Solstice of 1822, and of the comet of Encke.

8. *On a Remarkable Case of Magnetic Intensity of a Chronometer.* By George Harvey, Esq. M. G. S. M. A. S. &c. —P. 117–126.

This ingenious and able paper will be regarded by philosophers as adding very important information to that which has already been laid before the public by Varley, Fisher, Barlow, and Scoresby. Mr Harvey found, by Coulomb's apparatus, that a box chronometer exhibited singular proofs of strong and active magnetism. It contained a remarkable quantity of steel, and every part of it exhibited vigorous polarity. Every screw displayed its influence, and the frame alone contained ten large and several small screws; and the same intense and active magnetic power was exhibited by the chain, the axles of the wheels and pinions, the arbor of the fusee, and the balance of its springs. Mr Cox, the agent for Arnold's chronometer at Plymouth, remarked, when he saw this chronometer, that it appeared nothing less than a *magazine of magnets.* Mr Scoresby recommends platina, or an alloy of platina, for the balance of chronometers. Gold is said to be considered as well adapted for the balance spring.

9. *Remarks concerning the Natural-Historical Determination of Diallage.* By William Haidinger, Esq.—P. 127–147.

In this paper, the Green Diallage of Haüy is demonstrated always to be a composition of thin films of Hornblende and of Augite, sometimes pure, sometimes the two species blended with each other. Besides this, the paper contains a description of

some of the most remarkable rocks containing green diallage, and an account of cleavable varieties of Saussurite, and of crystals of Serpentine.

10. *Investigation of Formulæ for finding the Logarithms of Trigonometrical Quantities from one another.* By William Wallace, F. R. S. Edin. and Professor of Mathematics in the University of Edinburgh.—P. 148–167.

11. *A proposed Improvement in the Solution of a Case in Plane Trigonometry.* By William Wallace, F. R. S. Edin. and Professor of Mathematics in the University of Edinburgh.—P. 168–170.

In the first of these papers, Professor Wallace has investigated rules for deducing the logarithms of trigonometrical functions from one another. Although the formulæ are only approximative, yet they are sufficiently accurate, and are, from their nature, well adapted to logarithmic calculation. These formulæ, which are highly useful, are not only new, but are characterised by their simplicity and compactness.

The second paper describes an improved method of solving the case in plane trigonometry, where two sides and the included angle are given to find the third side.

12. *Some Notices concerning the Plants of various Parts of India, and concerning the Sanscrita Names of those Regions.* By Francis Hamilton, M. D. F.R.S. & F.A.S. Lond. & Edin.—P. 171.

This interesting paper contains an account of Dr Francis Hamilton's botanical tour in India. The object of the paper is to put upon record an account of the opportunities which he enjoyed of making observations on the botany of India, during his residence in that country, with the view of explaining to the botanist where he may find the various collections which he made in different districts. The botanical observations which our author made in India will immediately appear. The paper is illustrated with a map of India according to the ancient divisions used in the Sanscrita language.

13. *On a New Species of Double Refraction, accompanying a remarkable Structure in the Mineral called Analcime.* By DAVID BREWSTER, LL.D. F.R.S. Lond. & Sec. R. S. Ed. —187–194.

An abstract of this paper is already given in this Number, p. 255.

14. *On the Specific Heat of the Gases.* By W. T. HAYCRAFT, Esq.—P. 195–216.

The experiments contained in this paper seem to have been conducted with great care, and great attention to accuracy, in every particular. The results which they seem to authorise, are, that all the gases examined, viz. oxygen, hydrogen, carbonic acid, azote, and carburetted hydrogen, have all their specific heats in the mean proportion of their specific gravities; that different states of combination of the gases with aqueous and other vapour, affect the capacities of the gases, and that probably, in some instances, in a regular arithmetical progression, corresponding with the arithmetical rate of expansive force of the gases, in different states of combination with vapour. The most interesting result to the physiologist is, that the air from the lungs has a less specific heat than atmospheric air, at a temperature of between 100½° and 95°. The air of respiration, at a temperature of 102° and upwards, and of 91° and downwards, had the same capacity as atmospheric air.

15. *On the Forms of Crystallisation of the Mineral called the Sulphato-tri-Carbonate of Lead.* By W. HAIDINGER, Esq. F.R.S.E.—P. 217–230.

An abstract of this paper is already given in this Number of the Journal. Independent of the mineralogical results which are given in this elaborate examination of the Sulphato-tri-Carbonate of Lead, it establishes, beyond a doubt, the accuracy of Dr Brewster's law relative to the connection between the primitive forms of minerals, and the number of their axes of double refraction, which Mr Brooke had called in question from an imperfect examination of the sulphato-tri-carbonate of lead.

Art. XXVII.—*Celestial Phenomena from April 1. to July 1. 1824, calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

April.

D	H	′	″	
2.	20	23	32	☌ ☽ ♄
4.	22	42	17	Em. II. sat. ♃
5.	22	46	36	☌ ☽ ♃
6.	22	6	35	☽ First Quarter.
7.	20	21	36	Em. III. sat. ♃
	21	58	6	Em. I. sat. ♃
8.	19	51	45	Im. IV. sat. ♃
	22	44	56	Em. IV. sat. ♃
11.	20	55	30	☌ ☽ ♂
13.	15	34	48	○ Full Moon.
14.	21	5	48	Im. III. sat. ♃
19.	22	6	16	☌ ☽ ♅
20.	3	49	3	☉ enters ♉
21.	5	56	29	☾ Last Quarter.
23.	20	17	52	Em. I. sat. ♃
27.	2	28	51	☌ ☽ ☿
29.	4	9	9	● New Moon.
30.	9	5	0	☌ ☽ ♄
	16	0	0	☌ ☽ ☿
	22	13	18	Em. I. sat. ♃

May.

D	H	′	″	
3.	11	16	52	☌ ☽ ♃
6.	3	59	31	☽ First Quarter.
	22	23	32	Em. II. sat. ♃
8.	21	59	20	☌ ☽ ♂
10.				☿ greatest elong.
13.	2	17	30	○ Full Moon.
17.	6	42	42	☌ ☽ ♅
21.	0	20	32	☾ Last Quarter.
	4	9	6	☉ enters ♊
27.	6	33	15	☌ ☽ ☿
	21	6	10	Im. III. sat. ♃
	22	48	53	☌ ☽ ♄
28.	14	46	45	● New Moon.
29.	4	52	41	☌ ☽ ☿
31.	2	48	51	☌ ☽ ♃

June.

D	H	′	″	
4.	8	44	30	☽ First Quarter
5.	12	46	20	☌ ☽ ♂
11.	14	24	37	○ Full Moon.
13.	13	13	56	☌ ☽ ♅
21.	0	25	30	☾ Last Quarter.
	12	48	37	☉ enters ♋
24.	15	30	28	☌ ☽ ♄
25.	8	0	0	☌ ☽ ☿
26.	7	10	0	☌ ☽ ♀
	23	28	54	● New Moon.
27.	21	38	42	☌ ☽ ♃
28.				☿ greatest elong.

On the 5th of April, the Moon will Eclipse the planet Jupiter.

Immersion, April 5,	$23^h\ 9'\ 39'',0$ at $3'\ 13'',9$ S.		of the ☽'s centre.
Emersion, —— 6,	0 4 23,6 at 3 33,6 N.		

The following are the Elements for this Occultation, as obtained from Delambre's Tables of the Sun, Burckhardt's Tables of the Moon, and Bouvard's Tables of 1821 for Jupiter :

Geocentric conjunction of the ☽ and ♃, at Edinburgh, *mean time*,	April 5,	$22^h\ 46'\ 47'',45$
Longitude of the Moon and Jupiter,		$93°\ 32'\ 6'',2$
Sun's Right Ascension,		14 52 1,1
Moon's Latitude North decreasing,		53 18,0
——— Equatorial Parallax,		58 35,6
——— Semidiameter,		15 57,7
——— Horary motion in Longitude,		34 24,33
——— ——— ——— in Latitude,		2 57,25
Sun's horary motion in Right Ascension,		2 16,9
Geocentric Latitude of Jupiter,		7 41,1
Jupiter's semidiameter,		18,24
——— horizontal parallax,		1,6

ART. XXVIII.—*Proceedings of the Royal Society of Edinburgh.* (Continued from p. 170.)

Jan. 12. 1824.—A Report by the Secretary was read, *On the Meteorological Registers kept at Hobart Town and Macquarrie's Harbour, Van Diemen's Land, with observations on the height of the tides, and the time of high water,* communicated by his Excellency Sir Thomas Brisbane, K. C. B. &c.

On the same evening, there was read, *Observations on a Galvanic Experiment of a paradoxical character,* by Professor Oersted. This paper is printed in the present Number, p. 205.

There was also read at this meeting, *An Introduction to a History of the Revival of Greek Literature in Italy in the 14th century,* by Patrick Fraser Tytler, Esq.

Mr Adie likewise exhibited to the Society the experiment of Professor Doberciner, of forming water by the action of pulverized platinum on oxygen and hydrogen.

Jan. 19.—There was read at this meeting, *Observations on an Anomalous Case of Vision,* by George Harvey, Esq.

At this meeting the following gentlemen were elected members:

HONORARY.

The Rev. John Brinkley, D. D. President of the Royal Irish Academy, &c. &c.
W. H. Wollaston, M. D. F. R. S. &c. &c.

FOREIGN.

William Haidinger, Esq.

ORDINARY.

George Harvey, Esq. Plymouth.
Dr Lawson Whalley, Lancaster.
William Bell, Esq. W. S. Edin.
Dr J. Hamilton *jun.* Professor of Midwifery in the University of Edinburgh.
Robert Groat, M. D. Edin.
Robert Grant, M. D. Edin.
Claud Russell, Esq. W. S. Edin.
H. W. Williams, Esq. Edin.
The Rev. William Muir, D.D.

Feb. 2.—A Report was read by the Secretary, *On Astronomical and Meteorological Observations made at the Observatory at Paramatta, New South Wales*, by his Excellency Sir Thomas Brisbane, K. C. B., and Mr Rumker.

At the same meeting there was read the first part of *Experiments and Observations on Thermo-magnetism*, by Thomas Traill, M. D. F. R. S. &c. &c.

At the same meeting the following gentlemen were elected members:

ORDINARY.

Alexander Munro, Esq.
W. H. Playfair, Esq. architect.

Feb. 17.—There was read at this meeting part 2d of *Experiments and Observations on Thermo-magnetism.*

At the same meeting there was read part of a *Journal of a Tour through the Himalaya Mountains*, by Messrs A. and G. Gerard.

March 1.—At this meeting was read a continuation of a Tour through the Himalaya Mountains, by Messrs A. and P. Gerard.

There was also read, *Observations on the Winter Solstice, made at Paramatta in* 1823, by his Excellency Sir Thomas Brisbane, K. C. B.

The following gentlemen were elected members:

ORDINARY.

John Argyle Robertson, Esq. surgeon.
Alexander Fisher, Esq. R. N.
James Pillans, Esq.
Dr Macwhirter, Edinburgh.
James Walker, Esq. civil engineer.
William Newbigging, Esq. surgeon.

March 15.—A paper by Dr Knox was read, entitled, *An Inquiry into the Structure and Functions of the Canal of Petit, and of the Marsupium nigrum, or that peculiar vascular tissue which traverses the vitreous humour in the eyes of Birds, Fishes, and Reptiles.*

Art XXIX.—*Proceedings of the Wernerian Natural History Society.* (Continued from. p. 172.)

Dec. 27. 1823.—Mr Greville read an account of a *Steinbart*, or Stone-axe, said to have been found imbedded in a layer of compact clay, under several beds of limestone, in Staffordshire; with remarks on the geological consequence of this fact, if ascertained to be correctly stated. At the same meeting Dr Knox read a communication from Dr Richardson, describing the quadrupeds met with on the shores of the inlets of Hudson's Bay, during Captain Parry's last voyage.

Jan. 10. 1824.—Dr Richardson read the first part of a general account of the animals collected and seen during the overland Arctic Expedition, illustrating his remarks by shewing prepared specimens of the animals.—Mr Walker Arnott then read a botanical disquisition, entitled, "*Remarks on some species of Mosses.*"

At this meeting the following gentlemen were admitted Members:

Ordinary.

Thomas Alexander Fraser of Lovat, Esq.
Charles Macalister, Esq.
John Wilson Anderson, Esq.
William Dunlop, Esq., Surgeon, and Lecturer on Forensic Medicine.

Corresponding.

The Reverend William Dunbar of Applegarth.
Thomas Horton James, Esq. London.

Jan. 24.—Dr Richardson read the concluding part of his account of animals collected during the overland Arctic Expedition.

Dr Knox then read a paper "*On the mode of growth, reproduction and structure of the poison-fangs of Serpents,*" illustrating his description by preserved specimens, anatomical preparations, and sketches.

At the same meeting, Mr Menteath of Closeburn communicated some remarks "*On the inexpediency of planting larch-trees over a subsoil of sandstone,*" and exhibited specimens, shew-

ing the early decay to which the base of the trunk is subject when this tree grows in such situations.

Feb. 7.—Mr Macgillivray gave a detail of the characters and synonyms of the species of the genus Larus, and at the same time exhibited specimens of the birds.—The Secretary read an account, contained in a letter to Professor Jameson from Lieut. Lamont of the 91st Regiment, of the capture in the West Indies of a very large Ray-fish, popularly called the Sea-devil, measuring 15 feet in width, and about as much in length.—Dr Grierson of Cockpen then read some general observations on Geology, Geognosy, Oryctognosy and Mineralogy, and on the respective nature of those various studies.

At this meeting the following gentlemen were elected non-resident members.

Sir William Purvis Hume Campbell, Bart.
Richard Dobson, M. D.

Feb. 21.—Dr Knox read a memoir on the osseous, muscular and nervous system of the Ornithorynchus paradoxus, illustrating his description of the osseous structure by a finely prepared skeleton of the animal.

The Secretary then communicated a deposition by three Shetland fishermen, Daniel and William Manson, and John Henderson, of Yell Island, emitted on oath before Arthur Nicolson Esq. of Lochend, J. P., relative to a small cetaceous animal, of very uncommon appearance, which they had accidentally captured at the deep-sea fishing, and taken into their boat, but soon afterwards released, in consequence of superstitious feelings. Considering the description as coming from uneducated fishermen, it seems tolerably accurate, agreeing in several important particulars with the character of the Herbivorous Cetacea, and confirming the opinion, long entertained, that our own seas are inhabited by an animal analogous to the dugong of the East Indies.

March 6.—Professor Jameson read a description of a layer of clay containing petrified shells, lying under a bed of basalt, in the Gawilghur range of hills in the East Indies, and also an account of the structure of the hill of Seetabuldee-Nagpoor, communicated by Mr Vaysey, surgeon to the Trigonometrical Survey, Hyderabad.—Mr Parry then read the first part of a paper

on the management of young plantations, recommending, in the fir-tribe, the practice of disbudding with the thumb at a very early period, in preference to pruning with the knife and saw at later times.

At the same meeting, there was shewn to the members a live Rattlesnake, which had just arrived from South Carolina, and which, on being irritated by means of a stick, sounded his rattle for some minutes.

ART. XXX.—*Proceedings of the Society of Scottish Antiquaries.*

Nov. 11. 1823.—A letter was read from Mr John Merricks to Dr Brewster, giving an account of a kettle of Roman metal found near Roslin.

Nov. 18.—There was read, 1*st*, An account of Macbeth's Castle at Inverness, as it existed about thirty years ago, by H. W. Williams, Esq. accompanied by a drawing; 2*dly*, Extracts from some remarks on the manners and customs of Orkney and Shetland, communicated by a very old, though anonymous correspondent of the Society, who adopts the signature of A. Z.

Nov. 29.—The following Gentlemen were elected Office-Bearers:

PRESIDENT.

The Right Hon. The Earl of ELGIN and KINCARDINE.

VICE-PRESIDENTS.

Sir Robert Dundas, Bart. Henry Jardine, Esq.
Sir John Hay, Bart.

COUNCIL.

Dr Brewster. Lord Meadowbank. Captain J. D. Boswall.
J. G. Dalyell, Esq. Gilbert Innes, Esq. Alex. Smellie, Esq.
Thomas Allan, Esq. Robert Stevenson, Esq. W. H. Anderson, Esq.

Robert Scott Moncrieff, Esq. TREASURER.

Samuel Hibbert, M. D. Thomas Kinnear, Esq. SECRETARIES.

The Rev. Alex. Brunton, D. D. SECRETARY FOR FOREIGN CORRESPONDENCE.

James Skene, Esq. CURATOR OF THE MUSEUM.

The thanks of the Society were unanimously voted to Alexander Smellie, Esq. for his valuable services to the Society as Secretary, during the many years that he has held that office.

Dec. 8.—There was read by James Skene, Esq., An account

of the Remains of an ancient Naumachia at Lyons, by Mons. Artaud;

Also, by the Secretary, A Narrative of the Parliament at Edinburgh in 1694; with the particulars of the seizure of Sir Patrick Hume at Polwarth.

Dec. 22.—The Secretaries read to the Society, 1*st*, An abstract of the Ecclesiastical Collections relative to Aberdeenshire, made by James Logan, Esq. of Mitcham, Surry;

2*dly*, Remarks occasioned by the similarity observed between certain Steinbarts or Stone-axes found near the Humber, in Lincolnshire, and those of Orkney and Shetland; by Dr Hibbert.

3*dly*, An account of the Proceedings of the Danish Society of Antiquaries; by Mr Trevelyan and.

4*thly*, Observation by the Secretary, on the ancient Bagpipes of England; accompanied by the Drawing of an English Bagpiper of the 16th century (from an old sculpture at Hulme Hall, Lancashire), which was transmitted to the Society by Captain Jones, 29th Regiment.

Jan. 26. 1824.—There was read a paper on the ancient Stone Circles and Cairns in the neighbourhood of Inverness; by George Anderson, Esq. of Inverness.

Mr Parry exhibited a series of Sketches, taken from carved oaken pannels in a Mansion at Newbury, Berks, which had formerly belonged to the famous Jack of Newbury, who entertained King Henry the Eighth.

Feb. 9.—The following communications were read:

1*st*, Notes on an ancient Cambro-British Ode, in praise of Galgacus, ascribed to Taliesin; by the Rev. H. T. Payne of Llanbeder.

2*dly*, Notice of a popular Tradition of the Parish of Eckford; by Warren Hastings Anderson, Esq.

3*dly*, Evidence relative to the alleged Scottish Pedigree of Sir Isaac Newton.

Feb. 23.—A paper was read by Dr Hibbert, on the Handfasting or Betrothing Customs of early times:

A Drawing by Major Hamilton of an ancient Danish Monument in the Parish of Kinglassie, Fife, was presented to the Society.

There was also exhibited certain original Letters written by the Ministers of Charles the Second to Francis Parry, Esq. British Envoy at Lisbon.

March 8.—Mr Macdonald laid before the Society copies of the following documents, preserved in the General Register House, viz.

> Precept by the Earl of Huntly to the Lord High Treasurer of Scotland, to pay L. 40 for perfuming the body of Henry Darnley.
>
> Precept (signed by Mary Queen of Scots) to the Treasurer to furnish various articles for her Mourning Dress, dated Feb. 15. 1566.

There was read the notice of an Ancient Golden Rod lately found near Inverness, by George Anderson, Esq.

A Drawing, by R. K. Greville, Esq. of an ancient Portable Font dug up near Bakewell, Derbyshire, was presented to the Society.

A paper was also read, on the Early Opinions entertained relative to Mermaids, by Dr Hibbert.

The preceding account is a satisfactory proof of the revival of the public taste on the subject of antiquities. It is indeed strongly evinced by the great accession of new members to the Society made during the present season, as well as by the valuable donations which have enriched the Museum.

Art. XXXI.—*Proceedings of the Cambridge Philosophical Society for* 1823. (Continued from p. 177.)

Nov. 10.—A letter was read from W. J. Bankes, Esq. M.P. for the University, on the subject of a MS. on papyrus of the last book of the Iliad, discovered at Elephantina in Upper Egypt.

A paper from G. B. Airy, B. A. of Trinity, explanatory of an instrument exhibited to the Society, for the purpose of proving by experiment the constancy of the ratio of the sines of incidence and refraction in liquids.

Remarks on the Temperature of the Egg, connected with Physiology, by John Murray, F. A. S., F. L. S.

Observations and Experiments on the Temperature developed in Voltaic action, and its unequal distribution, by the same.

Nov. 24.—Mr Whewell read a paper, in which he deduced a formula for the angle between two *planes*, whose equations are given, when the three coordinates to which they are referred make any angles whatever. To this was annexed a corresponding investigation by Mr Lubbock of the angle contained between any two *lines* referred to coordinates of the same description.

A paper by Dr Gregory was read, containing an account of some experiments, made in order to determine the velocity with which sound is transmitted through the atmosphere. Some of the results of these experiments are the following. That wind greatly affects sound in point of *intensity*, and that it affects it also in point of velocity;—that when the direction of the wind *concurs* with that of the sound, the *sum* of their separate velocities gives the *apparent* velocity of sound; when the direction of the wind *opposes* that of the sound, the *difference* of the separate velocities must be taken;—that in the case of echoes, the velocity of the *reflected* sound is the same as that of the *direct* sound, that, therefore, distances may frequently be measured by means of echoes;—that an augmentation of temperature occasions an augmentation of the velocity of sound, and *vice versa*.

Dr Gregory mentions in a postscript, that it appears from experiments made by Mr Goldingham at Madras, (See this volume, pp. 182–183.), that the velocity of sound is different in different climates; and that hygrometric changes are not without their influence.

Dec. 8.—Mr Peacock concluded his paper on the Newtonian discoveries, and read to the Society three unedited letters of Sir Isaac Newton to Dr Keith, preserved in the Library of Trinity College, Cambridge.

Professor Cumming exhibited to the Society some experiments connected with the inflammation of hydrogen gas, when propelled upon platinum.

Art. XXXII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Struve's Observations on the Parallax of the Fixed Stars.*—M. Struve, in the second and third volumes of his Astronomical Observations, has given the results of his method of determining the sum of the parallaxes of several fixed stars, differing nearly 12 hours in right ascension, by means of a transit instrument furnished with seven wires. M. Struve gives 0″.16 as the parallax of δ Ursæ majoris, and 0″.45 as the sum of the parallaxes of α Cygni and ι Ursæ majoris.

2. *Elements of the Comet of* 1824.—The following are the elements of the comet of 1824, as deduced by the Reverend Dr Brinkley of Dublin from numerous observations:

Passage of the Perihelion, Mean Time at Dublin, 1823, Dec. 9d. 5h 10′ 12″	
Perihelion distance, - - -	0.23385
Inclination of Orbit, - - -	76° 1′ 43″
Ascending Node, - - - -	303° 0′ 44″
Place of Perihelion, - - -	273 41 50
Motion retrograde.	

This comet, which does not seem to have been observed before, has nearly the same inclination and perihelion distance as that of 1677, the perihelion distance of the latter being 0.28059, and its inclination 79° 3′ 15″; but in the other elements there is [illegible] agreement. On the 26th of January the comet was about 45 millions of miles distant from the earth.

The following elements are given by Encke and other astronomers in Professor Shumacher's *Astronomische Nachrichten*, No. 48. p. 491.

Passage of Perihelion, -	Dec. 9d.50660 Seeberg.
Long. of Perihelion, - -	275° 7′ 39″.2
Long. of Node, - -	303 8 35.4
Inclination of Orbit, - -	74 14 20
Log. of Perihelion distance, -	9.3505684

The following are the elements given by M. Hansen:

Passage of Perihelion, -	Dec. 9d.47193 Altona.
Long. of Perihelion, - -	274° 33′ 26″
Long. of Node, - -	303 3 22.2
Inclination of Orbit, - -	76 11 22.5
Log of Perihelion distance, -	9.355[illegible]934

The following are the elements given by M. Nicolai:

Passage of Perihelion,	-	Dec. 9d.4380 Manheim.
Long. of Perihelion,	- -	274° 18′ 32″
Long. of Node,	- -	303 1 18

3. *Observations of the Eclipses of Jupiter's Satellites, made at the Royal Observatory, Greenwich.*—The following observations were made by Mr Pond at the Royal Observatory at Greenwich, in the years 1820, 1821, and 1822. They are peculiarly valuable, for determining the longitudes of places where corresponding observations have been made:

Year and Day.	What Satellite.	Immersion or Emersion.	Mean Time.	Year and Day.	What Satellite.	Immersion or Emersion.	Mean Time.
1820,			h ′ ″	1822,			h ′ ″
July 16,	2	Im.	14 7 54,7	Jan. 14,	1	Em.	6 23 49,7
Aug. 10,	2	Im.	11 15 40,0	Feb. 6,	1	Em.	6 41 6,9
13,	1	Im.	13 53 42,4	Mar. 1,	1	Im.	6 58 1,6
22,	1	Im.	10 16 17,5	Aug. 28,	3	Im.	13 29 36,5
Sept. 3,	3	Im.	14 34 57,4	30,	1	Em.	11 59 32,3
4,	2	Im.	8 20 55,5	30,	2	Im.	13 5 37,3
5,	1	Im.	14 4 49,4	Sept. 6,	2	Im.	13 9 5,6
29,	2	Em.	8 11 50,6	6,	1	Im.	13 53 [illegible],5
30,	1	Em.	11 1 46,0	13,	2	Im.	15 46 4,8
Nov. 1,	1	Em.	7 42 11,3	13,	1	Im.	15 46 32,8
15,	1	Em.	11 34 16,4	29,	1	Im.	14 2 20,7
				Oct. 3,	3	Em.	11 36 10,0
				8,	1	Im.	10 24 14,2
				8,	2	Im.	12 57 6,0
1821,				10,	3	Im.	13 29 5,8
July 26,	1	Im.	11 50 32,7	10,	3	Em.	15 34 56,0
Aug. 4,	2	Im.	11 6 6,6	22,	1	Im.	14 11 33,9
11,	2	Im.	13 42 58,9	22,	2	Im.	18 [illegible] 6,5
Sept. 3,	1	Im.	10 17 25,0	26,	2	Im.	7 28 0,7
5,	2	Im.	10 53 19,4	29,	1	Im.	16 5 39,6
11,	3	Em.	10 34 4,2	Nov. 2,	2	Im.	10 6 49,5
12,	2	Im.	13 31 9,9	5,	1	Im.	17 59 23,3
24,	1	Im.	15 58 31,9	7,	1	Im.	12 28 18,9
Oct. 7,	2	Im.	10 40 24,9	16,	1	Im.	8 51 59,5
28,	1	Em.	9 11 19,5	16,	2	Im.	15 21 1[illegible],4
Nov. 4,	1	Em.	11 6 18,8	21,	1	Im.	16 15 9 9
27,	1	Em.	11 21 31,8	Dec. 11,	2	Em.	15 5 37,6
29,	3	Em.	6 43 13,4	21,	3	Im.	5 30 17,8
Dec. 6,	1	Em.	7 46 25,5	21,	3	Em.	7 45 3,6
6,	3	Im.	8 36 10,3	25,	1	Em.	9 29 46,2
22,	1	Em.	6 6 43.7	28,	3	Im.	9 31 15,1
				29,	2	Em.	9 37 57,0

4. *New Tide Gauge.*—This proposed gauge consists of a pipe with an open mouth, and a triangular orifice at its side, in contact with any convenient part of a bridge or pier, that is situated

below low-water-mark. From this pipe is brought another, like those for distributing gas, terminating in a well closed reservoir, provided with a little forcing syringe, and with an open barometer gauge, to which may be added, if necessary, a manometrical gauge. Before each observation, the syringe should be worked till the gauge becomes stationary, by the escape of the air under the water, so that the column of compressed air may always begin from the level of the upper angle of the triangular orifice; the height of the gauge will then obviously indicate the height of the surface of water above this level.—Quarterly *Journal of Science*, No. 32. p. 348.

OPTICS.

5. *Unusual Parhelia seen at the Cape.*—On the 7th May 1823, when the sun's lower limb had just dipped the water's edge, the Reverend Mr Fallows observed several parhelia, viz. 4 on the left, and 3 on the right hand of the sun, and all cut by the horizon like the real sun. They had the same shape as the real sun, and were as high, but not so long. When the upper limb of the sun came in contact with the horizon, it and the mock suns appeared as bright points upon the water's edge, and then one of them instantaneously vanished. The barometer was at 30.2 inches, and the thermometer at 64°. Dr Young supposes that these parhelia were only *fragments of coronæ*, formed by the diffraction of a cloud rising but little above the horizon; and he attributes the absence of colours to the absorption of all the light except the red, in its long passage through a hazy atmosphere.

The phenomenon now described we consider as very remarkable, and as one hitherto unobserved; but we cannot, for the following reasons, concur in the ingenious explanation of it given by Dr Young:

1. Mr Fallows distinctly states that *not a cloud* was visible.

2. He distinctly describes, and draws the mock suns as having *exactly the shape of the real sun*,—a form which fragments of coronæ could not be supposed to assume.

3. He describes them *as equal in brightness* to the real sun, which they could not possibly be, if they were fragments of co-

ronæ, unless some obstructing medium obscured the light of the real sun, without affecting that of the coronæ.

Mr Fallows describes the sky *as delightfully clear*, without a cloud visible, and the *sea horizon as remarkably distinct*, so that there appears to be no ground for a physical explanation of the phenomenon, unless we could suppose a recurrence in different azimuths on each side of the sun, of that condition of the atmosphere which produces lateral mirage. It deserves to be noticed, that, according to the diagram of Mr Fallows, all the mock suns were included in a space extending only *one degree and a half* on each side of the sun's centre.

6. *Large Achromatic Telescopes in France.*—At the Exposition of French Industry, several large Telescopes were exhibited by MM. Lerebours and Cauchoix, constructed with Flint-Glass, made by M. Guinand of Neuchatel. One made by Lerebours had its object-glass 9 inches in diameter French measure, and its focal length 10½ feet; and another by M. Cauchoix, had the diameter of the object-glass 11 inches, and the focal length 18 feet. We hope that the performance of these Telescopes will correspond with their dimensions.—See Vol. IX. p. 392.

7. *Purple Colour of Glass increased by Light.*—M. Faraday has found, that by the exposure of plate-glass with a purple tinge to the sun's rays, during nine months, the purple tint had increased considerably, while pieces of the same glass, kept in the dark, had suffered no change.—*Quart. Journ.* No. xxxi. p. 164.

ACOUSTICS.

8. *Influence of Sounds on the Elephant and Lion.*—In the human ear the fibres of the circular tympanum radiate from its centre to its circumference, and are of equal length; but Sir E. Home has found that in the elephant, where the tympanum is oval, they are of different lengths, like the radii from the focus of an ellipse. He considers that the human ear is adapted for musical sounds by the equality of the radii, and he is of opinion that the long fibres in the tympanum of the elephant enable it to hear very minute sounds, which it is known to do. A piano-

forte having been sent on purpose to Exeter Change, the higher notes hardly attracted the elephant's notice, but the low ones roused his attention. The effect of the higher notes of the piano-forte upon the great lion in Exeter Change was only to excite his attention, which was very great. He remained silent and motionless. But no sooner were the flat notes sounded, than he sprang up, attempted to break loose, lashed his tail, and seemed so furious and enraged as to frighten the female spectators. This was attended with the deepest yells, which ceased with the music. Sir E. Home has found this inequality of the fibres in neat-cattle, the horse, deer, the hare, and the cat. See *Phil. Trans.* 1823, pp. 23–26.

METEOROLOGY.

9. *Remarkable Waterspout in France in* 1823.—In the arrondissemens of Dreux and of Mantes, about 3 o'clock of the 26th of August 1823, a storm came on from the SW., accompanied with a sudden and powerful heat. A waterspout was seen not far from the village of Boncourt, having its broad base resting on the ground, and its summit lost in the clouds. It consisted of a thick and blackish vapour, in the *middle of which were often seen flames in several directions.* Advancing along with the storm, it broke or tore up by the roots, in the space of a league, seven or eight hundred trees of different sizes, and at last burst with great violence in the village of Marchepoy, one half of the houses of which were instantly destroyed. The walls, overturned to their foundations, rolled down on all sides; the roofs, when carried off, broke in pieces, and the debris were dragged to the distance of half a league by the force of this aërial torrent. Some of the inhabitants were crushed to pieces, or wounded by the fall of their houses, and those who were occupied in the labours of the field, were overthrown or blown away by the whirlwind. Hailstones as large as the fist, and stones and other foreign bodies carried off by the wind, injured several individuals. Carts heavily loaded were broken in pieces, and their loads dispersed. Their axle-trees were broken, and the wheels were found at the distance of 200 or 300 paces from the spot where they were overturned. One of these carts, which had been carried off almost bodily, was pitched above a tile-

kiln, which had been beaten down, and some of the materials of which had been carried to a considerable distance. A spire, several hamlets, and different insulated houses, were overthrown. Several villages were considerably injured. The lower part of the waterspout is supposed to have been about 100 toises in diameter.—See the *Moniteur* of the 31st October, where the account is signed by M. Foucault, and the *Bibl. Univers.* Oct. 1823. p. 138.

10. *Waterspout near Genoa in* 1823.—In the communes of Quigliano and Valeggia, in the province of Savona, a heavy rain fell on the 16th September, at 5 o'clock in the morning. It increased to such a degree, that at 9 o'clock in the morning the country was inundated. Towards noon there issued from a mountain situated in the parish of Valeggia, a whirlwind of black smoke and fire. It first carried off the roof of a house, in which two children were crushed to pieces, and the parents wounded. The waterspout then advanced to the opposite side of the mountain called Magliolo; crossed the river, the waters of which it heaped up in an instant, though they were much swelled;—carried off the roofs of two inhabited houses, and advanced along the same mountain in the district of Quigliano, where it dissipated itself near the Convent of Capuchins, situated in the village. It tore up many large trees of all kinds, and committed ravages, the extent of which is not yet known. The preceding account was sent by the Commandant of the Province of Savona to the Governor of Genoa, in a letter, part of which is published in the *Moniteur* of the 1st October, and in the *Bibl. Univers.*, Nov. 1823, p. 135.

11. *Aurora Borealis.*—Dr L. Thienemann, who spent the winter of 1820 and 1821, in Iceland, made numerous observations on the polar lights. He states the following as some of the general results of his observations:

1. The polar lights are situated in the lightest and highest clouds of our atmosphere.

2. They are not confined to the winter season, or to the night, but are present, in favourable circumstances, at all times, but are only distinctly visible during the absence of the solar rays.

3. The Polar lights have no determinate connection with the earth.

4. He never heard any noise proceed from them.

5. Their common form, in Iceland, is the arched, and in a direction from NE. and W.SW.

6. Their motions are various, but always within the limits of clouds containing them.

HYDRODYNAMICS.

12. *Perkins's Steam-Engine.*—The delay which has taken place in the construction of Mr Perkins's steam-engine, has arisen solely from the difficulty of constructing a generator capable of retaining the steam under high pressure, without leakage at the seams and joints. Under this difficulty, Mr Perkins most properly declined to exhibit an imperfect experiment, which would have destroyed the character of his invention. We are glad, however, to find, that Mr James Russell of Wednesbury, has succeeded in constructing a generator of wrought iron, without any seam or rivets, which we learn has been proved to resist the enormous and incredible pressure of *twenty thousand pounds* upon every inch of its surface. Mr Perkins considers this extraordinary piece of workmanship as enabling him to surmount all his practical difficulties.—See Newton's *Journal of the Arts*, vol. vii. p. 148.

13. *Mr Perkins's Steam-Guns.*—The great power of Mr Perkins's engine he has recently illustrated by some singular experiments. He has constructed a small apparatus, which, when connected with the generator, has been found to discharge ordinary musket-bullets at the rate of 240 in the minute, and with such tremendous force, that after passing through an inch deal, the ball, in striking against an iron-target, became flattened on one side, and squeezed out. The original size of the bullets was 0·65 of an inch, but after striking the target, they were plano-convex, and their diameter 1.070 inches, and 0.29 of an inch thick.—*Id.* p. 107.

II. CHEMISTRY.

14. *On the Nature of the Atmosphere of Seas.*—In a curious paper on this subject, published by M. Vogel of Munich, in the

Journal de Pharmacie, No. 11., for November 1823, p. 501. 506., this learned chemist has given the following results. 1. That the air of the Channel between Dieppe and Havre contains muriates. 2. That the air of the Channel, as well as the air of the Baltic, contains a less quantity of carbonic acid than the air of the Continent. 3. That the muriates do not disengage their acid, at a temperature capable of bringing them to ebullition, but that they are partly volatilised with the vapours of the water. 4. That there is no particular colouring principle in sea-air, as M. Hermbstaedt of Berlin thought; and that the red colour produced by nitrate of silver with the aid of the sun, is due rather to the muriates. 5. That all water whatever, which contains traces of a muriate, possesses the property of acquiring a wine-red colour, with nitrate of silver, when exposed to the sun.

15. *New Pyrophorus of Tartrate of Lead.*—In determining the composition of tartrate of lead, Dr Friedmann Gobel of Jena observed, that this salt, when heated in a glass tube, formed a fine pyrophorus. When a portion of the deep brown mass is projected from the tube, it instantly takes fire, and brilliant globules of metallic lead appear on the surface of the substance in ignition. The effect continues much longer than in other pyrophori.

16. *On the Hydroduret of Carbon.*—This substance, discovered by M. Serullas, is a solid, which crystallises in brilliant scales, and has a specific gravity nearly double that of water. It is of a citron yellow colour, with a sweet taste. It is insoluble in water, but soluble in 80 parts of alcohol, at 33° centigrade, the ordinary temperature, and in 25 parts at the temperature of 35°. It is soluble in seven times its weight of ether. It is readily dissolved by the fat of volatile oils.

		Gramme.	
One gramme of it consists of,	Iodine,	0.8991	1 atom.
	Carbon,	0.0864	2 atoms.
	Hydrogen,	0.0144	2 atoms.

M. Serullas has found, that this salt may be obtained in abundance, by simply treating an alcoholic solution of iodine by an alcoholic solution of potash of soda.—*Journal de Pharmacie*, November 1823, p. 514.–520.

17. *Test-Paper for Acids, Alkalies, and Compound Salts.*—A useful test-paper has been submitted to the Society of Arts of London, by Mr Thomas Griffiths. Acids change the blue colour of the test-paper into red, and alkalies change it into green. It is thus prepared. A pound of the minced leaves of red cabbage, are boiled in a pint of distilled water, till all the blue colour is extracted. The liquor is then strained through a cloth or sieve, and the clear infusion, which is of a fine blue colour, is to be evaporated to half its bulk, and poured into a shallow dish. The paper may then be dipped into it, and hung on lines to dry. A sheet of the filtering paper, which is the kind used, absorbs two fluid ounces of the infusion. With this test-paper, only one drop of the solution to be boiled is required. There are, no doubt, several processes, in which a test for acid and alkali at one operation may be found advantageous. See the *Transactions of the Society of Arts for* 1823, vol. xli. p. 78.

18. *Mineral Waters.*—M. Berzelius has found in mineral waters, many substances which have not hitherto been observed in them, viz. *fluate of lime*, *carbonate of strontian*, *phosphate of lime*, and *phosphate of alumina*. These substances are found in the waters of Carlsbad, dissolved in carbonic acid uncombined. The tufas deposited by these waters are *arragonitic*, which confirms the idea of M. Stromeyer, that it is the carbonate of Strontian which determines the arragonitic form of the species of carbonate of lime.—Professor Silliman's *American Journal*, vol. vii. p. 185.

19. *Reduction of Uranium.*—M. Arfwedson has found, that uranium is very reducible by means of hydrogen gas, at a temperature scarcely equal to redness. The combination of the yellow oxide of uranium, with barytes, lead and iron, are reducible in the same way, and give metallic uranures, which take fire when they come in contact with air, and burn like pyrophori.—Professor Silliman's *American Journal*, vol. vii. p. 185.

20. *On the Corrosion of the Coppering of Ships.*—At a meeting of the Royal Society on the 22d January, Sir Humphry Davy read a paper on the cause of the decay and corrosion of the coppering of ships, which he ascribed to a constant though feeble chemical action of the saline parts on the surface of the copper.

This action he considers as galvanic; and it is known, that some copper suffers comparatively little corrosion to that which takes place where the copper contains a small quantity of zinc or any other metal. In order to remedy this great practical evil, Sir Humphry Davy has shewn, that if a very small surface of tin is brought into contact with a surface of copper 100 times its size, it will render the copper so negatively electrical, that the sea-water is no longer able to corrode it. The same effect was produced when a small piece of tin was made to communicate with a large surface of copper by means of a wire. We are informed by a friend (who saw the result of the experiment), that with a piece of Mr Mushet's patent copper, a piece of common copper, and a piece of the one rendered negatively electrical by zinc, and subjected to the action of salt-water, the common copper was highly corroded, and the patent copper less so, while the negatively electrical copper was not affected at all. This elegant invention of Sir Humphry Davy, will, we doubt not, be well appreciated by the government and the public.

III. NATURAL HISTORY.

MINERALOGY.

21. *Notice regarding a Fossil having the smell of Truffles.*—A singular fossil, which, on percussion, exhales an odour resembling that of truffles, has long been known in Italy under the name of abestiform Madreporite, Tartufoli, and xyloid Tartuffite, and resembles in smell the lignite of Wieliczka. It has been discovered at Ecouche, Frenay-le-Buffard (Orne), Curcy and Croisilles, near Aunay (Calvados). The tartuffite presents round or polyhedral stems, converted into acicular carbonate of lime, and seems to be allied to the monocotyledones. Its smell is probably the result of a new combination of the volatile principles of vegetables, and is owing to the presence of a bitumen, susceptible of being fixed in water, and sometimes in the proportion of 4 *per cent.* In France, the position of this fossil, according to Desnoyers, is in the calcareous, sandy, or argillaceous beds among the middle Jura oolites; but in the Vicentin it occurs in the midst of the tertiary volcanic tufa.

22. *Forms of Crystallisation of Melted Sulphur.*—Professor Mitscherlich succeeded in obtaining crystals of sulphur of consi-

derable size and quite transparent, but becoming soon opaque on exposure to the air, when he allowed masses of fifty pounds weight of sulphur, melted in a common earthenware pot, to cool slowly. The form of these crystals differs from that of the crystals of native sulphur, the latter being combinations of the prismatic system, as described by Haüy, while the former affect the hemiprismatic form of oblique-angular foursided prisms of 90° 32′, terminated by oblique planes, which are set on the obtuse lateral edges at an angle of 95° 46′, variously modified by additional planes, and grouped in twin crystals. Crystals having the same forms as those observed in native sulphur were obtained when sulphur has been dissolved in the carburet, chloruret, and phosphuret of sulphur, and the one kind of crystals may be changed into the other, according to the different methods employed for obtaining them. In these crystallisations of sulphur we have a new well authenticated fact, in addition to carbonate of lime, biphosphate of soda, and sulphuret of iron, that the same chemical substances, at least, in so far as our present knowledge goes, may assume two different and incompatible forms of crystallisation, or what is the same thing, that two really distinct and well defined species may consist of the same constituent parts. Professor Mitscherlich has obtained large and beautiful rhomboidal dodecahedral crystals of phosphorus from solutions of this substance in phosphuret of sulphur.—*Annales de Chimie et de Physique*, t. xxiv. p. 264.

23. *Greywacke of the Apennines.*—It would appear from the observations of Dr Boué, that the rock described by Hausmann, in his account of the Apennines in a former number of this Journal, is not true greywacke, but marly variegated sandstone. Dr Boué found this greywacke of Hausmann, his variegated sandstone, resting upon magnesian limestone (zechstein) in the Alps and the Carpathians. The tertiary formations of the Apennines, Dr Boué informs us, are similar to those in Hungary and Austria.

24. *Secondary Granite.*—The discovery of new granite resting upon sandstone and secondary limestone, mentioned at p. 403. of vol. viii. of this Journal, appears to be confirmed by some later observations of Bertrand Geslin, a pupil of Brongniart.

25. *Humboldt's Geognosy.*—A new edition of this work, with numerous additions and many corrections, will soon appear in Paris.

28. *Iron found in Bogota, in America.*—Humboldt lately communicated to the French Academy of Sciences an extract of a letter from M. Boussingault, at Santa Fé de Bogota, in which that traveller states, that he found in the Cordillera of Santa Rosa, between Timja and Bogota, many masses of very ductile native iron, one of which weighed about 30 quintals.

BOTANY.

26. *Memoir on the Structure of the Monocotyledones.*—The author of this memoir, T. Lestiboudois, Professor of Botany at Lille, is already well known by a Dissertation, which he published in 1819, on the family of Cyperaceæ, and in which he has not only traced the characters of all the genera belonging to this class hitherto known, but has proposed the establishment of several new genera. The memoir which we at present announce, relates to the anatomical structure of the stem of the Monocotyledones. It is well known that the stem of unilobous plants is not organised, and does not grow in the same manner as that of the dicotyledonous plants. In place of presenting, like these latter, a regular succession of ligneous strata, circularly arranged and enclosed the one within the other, around a central canal, destined to contain the medulla, the stem of a palm, or other arborescent monocotyledon, presents only a mass of cellular tissue, in the midst of which are scattered ligneous fibres in irregular bundles. It is by the formation of new layers, which are annually added to the outer surface of the ligneous body, and to the inner face of the cortical body, that the dicotyledones grow in thickness. In the monocotyledones, on the contrary, the growth takes place by the centre of the stem. In the former there exists two different systems, the one, central or ligneous, which grows externally; the other, external or cortical, growing internally. There are therefore in these vegetables two sources of growth, while in the monocotyledones there exists but a single system, and a single focus of growth; and as this one system grows internally, as has been proved by the beautiful observations of M. Desfontaines, the author of the memoir thinks that it is the same as the cortical system of the monocotyledones. From whence is derived the conclusion, that the stem of palms, and of all other unilobous vegetables, is organised like the bark of the bilobous trees. On this account, he says, the dicotyle-

dones might be called *Digènes*, because they have two surfaces of growth; the monocotyledones, which have only one, might be named *Monogènes;* and the agamic or cryptogamic plants, *Agènes.—Bullet. Universel.*

ZOOLOGY.

27. *Occasional Abundance and supposed Migrations of Field-Mice.*—Field-mice appeared in extraordinary numbers in Morvern, about the year 1809 or 1810. They were first observed in the month of August, and disappeared during the ensuing winter. They were most numerous in the north, on Loch Sunart side of Morvern, where the country is wildest and most rugged, and where there is least arable land. On the coast of the Sound of Mull, their numbers were comparatively trifling. They also infested the districts of Sunart, Ardnamurchan, Moidart, Arisaig, and Ardgour. In Morvern, during the months of August and September, any spot of fine pasture in the hills was cut in roads, close to the ground. The grass cut by the root lay withered. Bushes were also cut by the root, in the same way; and the white interior substance gathered in heaps for nests. About the end of October and beginning of November, in woods and low grounds preserved for winter grazing, the grass was found cut in the same way as in the hills. The bark of young wood was frequently gnawed off, and the ground perforated to such a degree, in making their subterraneous residences, that it often yielded to the foot in walking. These subterraneous residences, it is supposed, were intended for winter quarters. It was observed, that the nests of the mice, above and below ground, all communicated with each other, by an amazing number of these cross-roads, formed by cutting the grass close to the ground; and every nest was invariably connected, by means of these roads, with some place where there was water. In Morvern, and it is believed in every quarter which the mice infested, they were most numerous in those farms where there is least crop; and, upon the whole, they destroyed much less crop than grass. This did not proceed from a want of relish for corn diet; for, in one farm in Morvern, where there is very little arable ground, the crop was completely destroyed. Even every square foot of the roof of the barn was perforated; and a great many of the stobs (sharp-pointed rods for fastening

the thatch), nearly cut through. It has been observed, that mice are more numerous during wet than dry seasons; and this season they are more numerous than usual. During the winter of the year in which they were numerous beyond all others, a long-continued and severe frost took place, and they then disappeared. It is supposed they perished from want of food or water. All opinions regarding the amount of damage done by these mice to the pastures, are mere conjectures, but it must have been very considerable. In one tenement in Moidart, having a stock of 2000 sheep, it was estimated as equal to that of 300 sheep of an over stock. In Ardgour, on the grounds around Colonel Maclean's residence, the mice destroyed an immense number of fir plants, and other young trees, by eating away the bark a little above the root. So bent were they here on mischief, that old women, with cats, were stationed at different points, in huts, through the plantations; at least it is generally reported that such was the case. It is not likely that these establishments could give any effectual check to their depredations. It is not probable that there was any thing like an *invasion* of this country by the mice, at the time they were so uncommonly numerous. It is more probable, that there was something in the season peculiarly favourable to their increase. There are always a considerable number of field-mice in the woods, where they live by hoarding up, under ground, great quantities of hazel-nuts; and in soft, moist ground, where there is long rank grass, or where the ground is coated with moss or fog, many of their nests and roads may be found under cover of the moss or grass. No facts occurred that would lead one to suppose that they migrate from one district of country to another.

28. *Salmon Fisheries in the River Tay.* — The salmon fisheries of the Tay may be divided into classes, the *River Fisheries* and the *Frith* or *Sea Fisheries.* The propriety of this distinction will readily appear by attending to the migrations of the salmon, and the most successful methods of capture, as these depend upon differences in the condition of the water in the River and in the Frith. Salmon, though inhabitants of the sea, approach the shores, enter our large rivers, and mount towards their sources, for the purpose of depositing the spawn in their gravelly beds. As soon as this object is accomplished,

they retire again to the sea, and evidently to great depths, remote from cod and haddock ground, to recruit their exhausted strength, and prepare for future efforts of the same kind. Before beginning their journey, they are in good condition, the body being loaded with fat, as a magazine for supplying the wants of the fish during migration, and for furnishing the great quantity of matter requisite for the evolution of the spawn. When the fish enter the Frith at the commencement of their upward migration, and are thus in good condition, they are termed, in the language of fishermen, *clean fish.* At this period they are infested with the Salmon louse, *Caligus productus* of naturalists, and which chiefly adhere to the more insensible parts. But when arrived at the place of spawning, the fish is lean, as the whole fat of the body has passed into the melt and the roe. In this state, in which they are termed *red fish,* they are worthless as an article of food. After the fish have spawned, they are termed *kelts* or *foul fish,* and are equally despised as the red fish. The gills are now more or less covered with the *Entomoda salmonea.* The motion of the fish upwards from the sea to the river and place of spawning, is influenced by several causes. When there is abundance of fresh water in the Frith, the fish seem to proceed regularly and rapidly up the middle of the stream, enter the rivers, and hasten on to their destination. Under these circumstances, it is probable that the ripening of the spawn is accelerated by the influence of favourable external circumstances. When the rivers are but scantily supplied with water, the fish, which have entered the Frith, roam about in it in an irregular manner, influenced by the state of the tide; while those which have been surprised in the rivers by a drought, betake themselves to the deepest pools. In returning to the sea after spawning, the fish seem to keep the middle of the stream in the river, and the deepest and saltest water in the Frith. Salmon enter the river and frith at all seasons of the year, but they approach in greatest numbers during the summer months. Fish taken in May, June, and July, are much fatter than fish in the same condition as to spawning, taken in February, March, or April. They fall off in fatness very rapidly from August to January, when they are leanest. The principal spawning season is in November, December, and January. The roe becomes

perfect, and the young fry, samlets or smolts (smouts) make their appearance in March or April. When the samlets leave the gravel, where the spawn from which they issued had been deposited, they begin to move downwards to the sea. In their progress through the river, and until they reach that point where the frith begins, (or where the tide is always either ebbing or flowing,) they crowd together, and descend in the easy water at the margin. But, upon entering the frith, where the easy water is not at the edge, they betake themselves to the deepest part of the channel, and, along with the kelts, disappear from observation.—*Rev. Dr Fleming.*

29. *Determination of the question relative to the origin of the domestic Dog.*—M. Desmoulins, considering, with Pallas, that the wild stock of all our old herbivorous animals still exists, notwithstanding the weakness of their means of defence and of preservation, as well as their limitation in respect to number, which bears no proportion to the multiplication of the species of the dog genus, and notwithstanding their various confinements to several islands, the Mouflon to Corsica, the Œgargus to Sardinia and Crete, &c.; has proved that the ox kind is not an exception, since it still existed in Poland not three centuries ago; that the domestic dogs again become wild, could not be destroyed, and that a species which has not yet been reduced to subjection, still possesses means of maintaining itself in a state of independence; that no historical testimony gives evidence of the extermination in any extensive country of any wild animal analogous to the dog; that all the presently existing species of this genus are mentioned by ancient authors in the countries with which they were acquainted; that there existed dogs in both Americas before the arrival of Columbus; that, according to Peter Martyr and Oviédo, there existed both in the Antilles and on the mainland, dogs of every description and colour; that the domestic dogs of the Antilles were not indigenous, and had been imported from the Continent; for in the time of Oviédo, who had seen them in great numbers on the Continent, they no longer existed in St Domingo, where, in a famine, during Columbus's second voyage, they had been destroyed to feed the population; that the Caribs, at this period, having the preponderant power of the east of the continent and of all the islands, must have introdu-

ved their dogs, which were so numerous on the continent, according to Oviédo; that at the present day, in the same countries, the natives train to the chase the wild dog of Cayenne, the *Canis Thoris* of Linnæus; that there is no proof of the Caribs having ever had any thing common in their origin or relations with the old continent; that their domestic dogs, therefore, had come from a wild species indigenous in their country, and that this species is necessarily either the grey wolf of Paraguay, the guaiacha of Brasil, or the wild dog of Cayenne, which is tamed at the present day, and which readily breeds with all the varieties of domestic dogs; that in the Papua Islands and in Australasia, there exists a wild species, the Papua dog or dingo, the resemblance of whose skull to that of our mastifs is not a decisive proof of the unity of the species, since resemblances equally great are very numerous among many widely separated species of mammifera, as has been so often established by M. Cuvier in his *Ossemens Fossiles*. Admitting the proofs already exposed by Guldenstædt (*Nov. Commen. Petrop.* t. 20), of the derivation of the domestic dog from the jackal; but, considering that it is impossible to derive from the jackal, either those dogs which existed previously to their discovery in the Antilles and in both Americas, or the Papou dog, or the woolly dog of the Esquimaux, &c.; that Buffon has himself proved the fecundity of the connections of the domestic dog with the wolf, that consequently the blood of the wolf must have produced many of our large varieties, that the fox has also been in some measure mingled with them, as was known in the days of Aristotle; and that thus, exclusive of the jackal, there are three wild species in Europe and western Asia, which have contributed to produce varieties of our domestic dogs: M. Desmoulins thence concludes, that the numerous races of domestic dogs must be referred each in its own country to different wild species; that, however, the emigrations along with man, of each of these species of domesticated dogs, have produced crosses of one domestic species with another, and races which have thence resulted sometimes with another, and sometimes with one or more of the wild species. Now, we know that the combination of the five wild species indicated, with all the domestic races, could easily give a still greater number of distinct races than the fifty or sixty at

present known. It is not therefore possible to admit any longer a single primitive species of dog, now destroyed, from which could have sprung all the varieties of domestic dogs known, by changes produced by the mere influence of climate and domestication.—*Bullet. Universel.*

IV. GENERAL SCIENCE.

30. *Earthquake felt at Sea.*—The East India Company's ship Winchelsea, on the 10th February 1823, at 1^h 10′ P. M., in E. Long. 85° 33′, and N. Lat. 52°, experienced a shock similar to that of an earthquake. A tremulous motion of the vessel, as if it were passing over a coral rock, alarmed all on board, and this was accompanied with a loud rumbling noise, both of which continued two or three minutes. As the ship was going only at two knots an hour, the Captain saw that there was no shoal, and considered the ship as out of soundings. There was no commotion on the sea, and the vessel was some hundred miles from land. This phenomenon has been ascribed to some volcanic eruption in one of the islands to the east of the Bay of Bengal. —Parsons in the *Med. Repository*, vol. xx. p. 175.

31. *Dr Hibbert's "Philosophy of Apparitions."*—Dr Hibbert has just published a popular and highly interesting work, entitled "Sketches of the Philosophy of Apparitions." This production was suggested by the interest that his paper on the same subject excited, when read during the course of the last winter to the Royal Society of Edinburgh. As the volume only reached us as the present number was going to press, we have merely time to glance at the general plan of the work, which may perhaps best be described in Dr Hibbert's own words. "In the first place," he observes, "a general view is given of the particular morbid affections with which the production of phantasms is often connected. Apparitions are likewise considered as nothing more than ideas or the recollected images of the mind, which have been rendered more vivid than actual impressions." In a second part of this work, he says, "my object has been to point out, that in well-authenticated ghost stories of a supposed supernatural character, the ideas which are rendered so unduly intense as to induce spectral illu-

sions, may be traced to such fantastical objects of prior belief as are incorporated in the various systems of superstition, which for ages have possessed the minds of the vulgar." In the succeeding and by far the most considerable part of this treatise, the research is of a novel kind. Since apparitions are ideas equalling or exceeding in vividness actual impressions, there ought to be some important and definite laws of the mind which have given rise to this undue degree of vividness. "It is therefore chiefly for the purpose of explaining such laws that the present dissertation is written. But I here enter into a perfectly new field of research, where far greater difficulties are to be encountered than I anticipated. The extent of them can indeed be only estimated by the metaphysician." The laws which govern the vividness of our feelings, Dr Hibbert explains in the various transitions which the mind undergoes, 1st, From perfect sleep to the common state of watchfulness; 2dly, From the ordinary tranquil state of watchfulness to that extreme condition of mental excitement which is conceived to be necessary for the production of spectral illusions; 3dly, From perfect and imperfect sleep to dreams and somnambulism. These laws meet with very striking illustrations; which, the author adds, "are not more numerous than the treatise requires, as my object is not only to render the principles which I have inculcated as intelligible as possible, but to direct the attention of the reader, less to the vulgar absurdities which are blended with ghost-stories, than to the important philosophical inferences which are frequently to be deduced from them. The subject of apparitions has, indeed, for centuries, occupied the attention of the learned; but seldom without reference to superstitious speculations. It is time, however, that these illusions should be viewed in a perfectly different light; for, if the conclusions to which I have arrived be correct, they are calculated, more than almost every other class of mental phenomena, to throw considerable light upon certain important laws connected with the physiology of the human mind."

32. *Ancient Inscriptions on Sheets of Lead.*—Prior to the invasion of Spain by the French armies, sheets of lead, inscribed with characters approaching the Arabic, were found rolled up, and concealed in fissures of rocks near the city of

Grenada. The discovery of these relics of antiquity arose from the accidental circumstance of a quarry having been formed on the spot. It was not doubted but that these deposites were made by the Moors, previous to their expulsion from Spain, which took place about the year 1491.—*Major Morison.*

33. *Pompeii and Vesuvius.*—"*Albergo Vittoria, 8th Feb.* 1824. —About 50 miles from this place, are the ruins of three temples, standing together on the sea-shore, at a place called *Pæstum.* We made up a party last week, and drove out to these ruins. It was cold clear weather, and the Apennines were covered with snow, but a more interesting trip we never made. The ruins are the most magnificent in Italy; particularly what is called the Temple of Neptune, with 14 large Doric pillars in length, and 8 in the other direction. Farther than these ruins, and the wall of the town, not a vestige of it remains; and, what is very singular, scarce a notice now exists of any account of the town, though it must have been a very considerable maritime place. Like most of the other places on that coast, it must have been a Greek settlement: but times, alas! have changed sadly with it; for now three solitary farm-houses are all that remain, owing to its being unhealthy in summer. There is something very incomprehensible about the unhealthiness of towns in Italy; for the town of Salerno, situated on a beautiful bay, which we passed along, is almost deserted by its inhabitants in summer; and yet they find safety at another small town, similarly situated, and not a mile off from it. In returning to Naples, on the third day, we stopped at a large sandy looking bank, on the right side of the road, about ten miles from town. The bank was that which destroyed *Pompeii*, A. D. 79; and we were now at the walls of that city. There are few things so strange as a walk through the silent streets of a town, which, for 1700 years, has been hid from the light of day and the world, when the manners and every day scenes of so remote an age stand revealed, unchanged, after so long an interval. It would appear, that, 16 years before the shower of sand and ashes from Vesuvius occurred, an earthquake had nearly ruined the town; so that the houses are roofless, partly from that cause, and from the weight of the ashes which fell. Otherwise, they stand just as they were left. The streets are narrow, but paved; and the

mark of the carriage-wheels in the lava pavement is evident. In Murat's time, 4000 men were employed in excavating; and so a great number of houses, perhaps one-third of the town, have been uncovered; but, at present, there are only 11 men and a few boys at work. I fancy the Neapolitans find the expence of giving 20,000 Austrian troops double pay a little troublesome; and so excavations must stand over for the present. The houses were all small, generally of two stories, but beautifully painted; and the figures of animals, such as horses, peacocks, &c. are as bright as that day they were painted. There are two theatres standing, and one amphitheatre, all nearly perfect; but I find it impossible to give you any idea of the wonders we saw in one walk through Pompeii. At one time, we walked up a street called the *Strada dei Mercantis*. On either side of us, the shops of Mosaic sellers, statuaries, bakers, &c. &c., with the owners' names painted in red, and the sign of his shop rudely carved above the door. The mill in the baker's shop, and the oven, amused us much. At another time, we passed through the Hall of Justice, the Temple of Hercules, the Villa of Cicero, and the Villa of Sallust. The only villa of three stories I observed, belonged to a man called Arrius Diomedes (his name was at the side of the door); and, in the cellar, beside some jars for wine, still standing, was the skeleton of this poor fellow, found with a purse in one hand, and some trinkets in his left, followed by another bearing up some silver and bronze vases, the last supposed to have been his servant. They had been trying to escape, by taking refuge in the cellar. Many other curious things have been discovered here, and a great deal may yet be brought to light; for, from a ticket of a sale stuck up on the wall of a house, it would appear that one person had no fewer than 900 shops to let. The street of the tombs is the most impressive: they are beautiful and extremely interesting. One for the gladiators has a representation of the different modes of fighting carved on it; and, from this it would seem, that they occasionally fought on *horseback;* which, before the discovery of Pompeii, was unknown. Here, however, I must stop, and leave you to hear more about the matter from my journal, which is very full.

On the 6th of this month, we made out our visit to the top

of *Vesuvius*. The ascent and descent along the lavas take about five hours. We had very fortunately Salvadori for our guide, who told us all about the different eruptions, &c. &c. The crater is not at all the thing I expected, but a gulph of most immense size, and one can see to the very bottom of it. I can scarcely believe what we were told, that it is 4½ miles round the crater, and that its depth is 2000 feet; but it is a most horrid, magnificent sight. Here and there a quantity of smoke is seen curling up the rocky sides; but at present the mountain is very quiet. All around is a dark, black looking waste of lavas, extending to the sea; and, near the foot, are the vineyards of the Lachryma Christi. In spite of the sad examples of Herculaneum and Pompeii, villages are sprinkled here and there, at the very foot of the mountain; and our guide told us, that one of them, called Torre del Greco, had now been destroyed fourteen different times, and another seven. The day was very clear and beautiful, and the view very fine. The country round Naples, towards the hills, is so rich and productive, that it is called the Campagna Felice; but still the people are poor and miserable.

34. *Effects of an Earthquake on the Vegetation of Wheat.*—It is a remarkable circumstance, that, since the great earthquake of 1687, no wheat will grow on the coast of Peru. In some places, indeed, a little is raised; but it is very unproductive. Rice, on the contrary, yields a great return. Before the earthquake, one grain of wheat yielded 200 grains.

35. *Maize Grain remarkably retentive of the power of Germinating.*—It is worthy of notice, that the maize which is found in the graves of the Peruvians, who lived before the arrival of Europeans in that country, is still so fresh, that, when planted, it grows well, and yields seed.

36. *Improved Sliding-Rule for gauging Casks.*—The object of this ingenious instrument or new Sliding-Rule, invented by Dr Thomas Young, is to determine, upon principles which are entirely new, and with the greatest possible simplicity and expedition, the approximate contents of any cask whatever, subject to any further corrections, which either theory or experience may dictate in particular cases. An account of this invention will be found in the *Quarterly Journal*, No. 32. p. 357.

37. *On Charcoal from different Woods.*—Mr T. Griffiths has published, in the Quarterly Journal of Science, No. 32. p. 265. some interesting experiments on charcoal, which we give in the following Table.

	Specific Gravity.	Proportion of Charcoal in 100 parts of Wood.
Lignum Vitæ, - - - -	1.342	17.5
Cocoas Wood, - - - -	1.336	22.5
Ebony, - - - -	1.226	30.5
Brazil Wood, - - -	1.132	26.
Satin Wood, - - -	1.078	20.7
Tulip Wood, - - -	1.070	20.8
King Wood, - - -	1.069	22.
Botany Bay Wood, - -	1·067	28.1

Mr Griffiths found, that charcoal from satin wood is the best conductor of electricity, and that from tulip wood the worst. The other charcoals discharge a battery with nearly the same effect.

38. *Mr Innes's New Tide-Tables.*—Mr George Innes of Aberdeen, to whom we are indebted for the calculation of the Celestial Phenomena, has published for 1825 an useful little work, entitled, New Tide Tables, shewing at sight the true time of high-water at Aberdeen and London, the sun's declination every day at noon, the eclipses, and the moon's age, with a Table, by which the true time of high-water at the principal ports along the coasts of Great Britain may be known.

39. *Mr Galbraith's Stereotyped Mathematical Tables.*—This work, from the pen of Mr William Galbraith, A. M., Lecturer on Mathematics, Edinburgh, contains improved Tables of Logarithms, of Numbers, of Logarithmic Sines, Tangents, and Secants; together with other Tables, useful in Practical Mathematics, Astronomy, Navigation, Engineering, and Business. They are preceded by a copious Introduction, embracing their explanation, and Rules and Formulæ of their application; with a collection of appropriate examples for solution. From a specimen of this work which we have seen, we have no doubt but that it will do great credit to the author.

40. *Engraving of a Brazilian Forest.*—Naturalists and travellers have essayed to make known to us the wild forests of South America: but neither the comprehensive descriptions of bota-

nists, nor the harmonious periods of the most eloquent writers, have succeeded in imaging to the European mind, features of which there exists no model in the whole compass of its acquirements. How, in fact, can words delineate that luxuriance of vegetation, that variety of forms, those wonderful contrasts, which excite to admiration the most indifferent spectator. An able pencil alone could succeed in delineating some of those majestic beauties; and this has been done by M. the Count de Clarac, with a degree of perfection to which we had scarcely considered it possible to attain. Without being a botanist, he has seized the character of each plant, and has given to all the species which he has represented their peculiar port and grace. The wild fig-trees present themselves with their arches, the mimosas with their finely divided foliage; the arborescent ferns and palms with their simple and elegant forms; the flexible stem of the bignoniæ, bauhiniæ and cissi bend into festoons, twist into cords, and closely tie together the neighbouring plants; the bamboos shoot up to a prodigious height; the cecropiæ display their digitate leaves; the balisier shows its buds, and the parasitic plants invest the fallen trunks with a new covering. In a word, every thing is beautiful in this design, because every thing is in strict accordance with nature; and it is to be wished that it may soon be followed by some others of those with which the portfolio of the author is filled.—*Bullet. Universel.*

ART. XXX.—*List of Patents granted in Scotland from 4th December* 1823 *to* 10*th March* 1824.

33. TO ARCHIBALD BUCHANAN of Catrine Cotton-works, one of the partners of the house of James Finlay and Co. merchants in Glasgow, for "an improvement in machinery heretofore employed in spinning-mills in the carding of cotton and other wool, whereby the top cards are regularly stripped and kept clean by the operation of the machinery, without the agency of hand labour." Sealed at Edinburgh 15th December 1823.

34. To THOMAS WOLRICH STANSFIELD of Leeds, county of York, worsted manufacturer; HENRY BRIGGS of Laddendenfoot, parish of Halifax, said county, worsted manufacturer; WILLIAM PRICHARD of Leeds, engineer; and WILLIAM BAR-

RACLEUGH of Burley, in the parish of Leeds, worsted manufacture, for "certain improvements in the construction of looms for weaving fabrics composed wholly or in part of woollen, worsted, cotton, linen, silk, or other materials, and in the machinery and implements, and methods of working the same." Sealed at Edinburgh 13th January 1824.

35. To WILLIAM FURNIVAL of Droitwich, salt-manufacturer, and ALEXANDER SMITH of Glasgow, master-mariner, for "an improved boiler for steam-engines and other purposes." Sealed at Edinburgh 13th January 1824.

36. To THOMAS BEWLEY of Mount-Rath, in Queen's County, Ireland, cotton manufacturer, for "certain improvements in wheeled carriages." Sealed at Edinburgh 30th January 1824.

37. To JOHN HEATHCOTE of Tiverton, county of Devon, lace-manufacturer, for "certain improvements in machines now in use for the manufacture of lace commonly called Bobbin-net, and a new method of manufacturing certain parts of such machines; as also, an improved and economical method of combining machinery used in the manufacture of lace, in weaving and in spinning worked by power; and also a machine for the manufacture of a plaited substance, composed either of silk, cotton, or other thread or yarn." Sealed at Edinburgh 30th January 1824.

38. To MILES TURNER and LAURENCE ANGELL, both of Whitehaven, county of Cumberland, soap-boilers, for "an improved process to be used in the bleaching of linen, or cotton yarn, or cloth." Sealed at Edinburgh 30th January 1824.

39. To THOMAS FOSTER GIMSON of Tiverton, county of Devon, gentleman, for an invention, communicated partly by a foreigner residing abroad, and partly made by himself, "of various improvements in, and additions to, certain machinery now in use for doubling and twisting cotton, silk, and other fibrous substances." Sealed at Edinburgh 20th February 1824.

40. To SAMUEL BROWN of Printing-House Square, London, engineer, for "an invention of an engine or instrument for effecting a vacuum, and thus producing powers by which water may be raised, and machinery put in motion." Sealed at Edinburgh 25th February 1824.

41. To PIERRE JEAN BAPTISTE VICTOR GOSSET of St John's Square, parish of Clerkenwell, county of Middlesex, merchant, for a communication by a foreigner residing abroad, "of an invention of a combination of machinery for producing various shapes, patterns, and sizes from metals, or other materials capable of receiving an oval, round, or other form." Sealed at Edinburgh 10th March 1824.

LIST OF PLATES IN VOL. X.

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